Flora of Chiapas

PUBLISHED BY THE CALIFORNIA ACADEMY OF SCIENCES

Part 1

INTRODUCTION TO THE *FLORA OF CHIAPAS*; *Dennis E. Breedlove*

Dennis E. Breedlove, Editor

Curator, Department of Botany
California Academy of Sciences

List of Families for *Flora of Chiapas* With Number of Species Known at Present
(those listed in *Flora of Guatemala* are in parentheses)

Ferns & Allies	638 (650)
Conifers	14 (23)
Acanthaceae	113 (133)
Aceraceae	2 (2)
Actinidiaceae	15 (12)
Aizoaceae	7 (5)
Alismataceae	7 (7)
Amaranthaceae	50 (46)
Anacardiaceae	22 (18)
Annonaceae	30 (31)
Apiaceae	59 (50)
Apocynaceae	63 (70)
Aquifoliaceae	18 (10)
Araceae	106 (65)
Araliaceae	20 (22)
Arecaceae	58 (83)
Aristolochiaceae	17 (15)
Asclepiadaceae	77 (90)
Asteraceae	602 (611)
Balanophoraceae	1 (1)
Balsaminaceae	3 (2)
Basellaceae	5 (4)
Batidaceae	1
Begoniaceae	45 (34)
Berberidaceae	9 (3)
Betulaceae	5 (6)
Bignoniaceae	50 (66)
Bixaceae	1 (1)
Bombacaceae	20 (14)
Boraginaceae	70 (65)
Brassicaceae	31 (34)
Bromeliaceae	126 (127)
Brunelliaceae	1 (1)
Burmanniaceae	5 (6)
Burseraceae	15 (12)
Butomaceae	1 (2)
Buxaceae	1 (2)
Cactaceae	42 (50)
Callitrichaceae	3 (2)
Campanulaceae	26 (33)
Cannaceae	5 (6)
Capparaceae	31 (28)
Caprifoliaceae	24 (18)
Caricaceae	9 (3)
Caryophyllaceae	36 (36)
Casuarinaceae	2 (1)
Celastraceae	52 (27)
Ceratophyllaceae	1 (1)
Chenopodiaceae	5 (5)
Chloranthaceae	1 (1)
Cistaceae	4 (5)
Clethraceae	16 (8)
Clusiaceae	29 (34)
Cochlospermaceae	2 (2)
Combretaceae	17 (14)
Commelinaceae	64 (40)
Connaraceae	4 (5)
Convolvulaceae	122 (144)
Coriariaceae	1 (1)
Cornaceae	2 (2)
Crassulaceae	31 (17)
Cucurbitaceae	56 (52)
Cunoniaceae	2 (2)
Cyclanthaceae	5 (5)
Cyperaceae	199 (185)
Cyrillaceae	(1)
Dichapetalaceae	3 (3)
Dilleniaceae	8 (8)
Dioscoreaceae	31 (24)
Droseraceae	3 (1)
Ebenaceae	9 (11)
Elatinaceae	1
Elaeocarpaceae	8 (7)
Ericaceae	44 (36)
Eriocaulaceae	2 (13)
Erythroxylaceae	8 (7)
Euphorbiaceae	256 (212)
Fabaceae	703 (553)
Fagaceae	39 (26)
Flacourtiaceae	49 (31)
Garryaceae	2 (2)
Gentianaceae	35 (36)
Geraniaceae	13 (7)
Gesneriaceae	59 (57)
Haemodoraceae	1 (1)
Haloragaceae	3 (3)
Hamamelidaceae	2 (3)
Hernandiaceae	3 (3)
Hippocastanaceae	1 (1)
Hippocrateaceae	12 (5)
Hydrocharitaceae	1 (3)
Hydrophyllaceae	10 (7)
Icacinaceae	6 (4)
Iridaceae	29 (22)
Juglandaceae	4 (5)
Juncaceae	16 (10)
Krameriaceae	2 (2)
Lacistemaceae	1 (1)
Lamiaceae	121 (100)
Lauraceae	96 (55)
Lecythidaceae	1 (2)
Lemnaceae	8 (7)
Lennoaceae	2 (1)
Lentibulariaceae	9 (17)
Liliaceae s.l	124 (100)
Linaceae	5 (4)
Loasaceae	9 (6)
Loganiaceae	29 (24)
Loranthaceae	43 (42)
Lythraceae	47 (34)
Magnoliaceae	5 (3)
Malpighiaceae	56 (49)
Malvaceae	125 (95)
Marantaceae	18 (14)
Marcgraviaceae	6 (10)
Martyniaceae	1 (2)
Mayacaceae	1 (1)
Melastomataceae	141 (154)
Meliaceae	37 (32)
Meliosmaceae	3 (4)
Menispermaceae	11 (11)
Monimiaceae	7 (3)
Monotropaceae	2 (2)
Moraceae	68 (64)
Moringaceae	1 (1)
Musaceae	21 (13)
Myricaceae	3 (3)
Myristicaceae	2 (5)
Myrsinaceae	61 (61)
Myrtaceae	85 (96)
Najadaceae	1 (2)
Nyctaginaceae	31 (24)
Nyssaceae	1
Nymphaeaceae	4 (5)
Ochnaceae	10 (7)
Olacaceae	10 (5)
Oleaceae	18 (12)
Onagraceae	44 (46)
Opiliaceae	3 (1)
Orchidaceae	514 (527)
Orobanchaceae	1 (1)
Oxalidaceae	23 (17)
Papaveraceae	9 (9)
Passifloraceae	42 (42)
Pedaliaceae	1 (1)
Phytolaccaceae	11 (13)
Piperaceae	106 (158)
Plantaginaceae	5 (4)
Platanaceae	1 (1)
Plumbaginaceae	3 (3)
Poaceae	461 (435)
Podostemaceae	3 (4)
Polemoniaceae	10 (10)
Polygalaceae	30 (34)
Polygonaceae	44 (35)
Pontederiaceae	8 (8)
Portulacaceae	7 (9)
Potamogetonaceae	8 (7)
Primulaceae	7 (5)
Proteaceae	2 (3)
Punicaceae	1 (1)
Pyrolaceae	5 (4)
Quiinaceae	(1)
Rafflesiaceae	4 (3)
Ranunculaceae	21 (18)
Resedaceae	(2)
Rhamnaceae	25 (22)
Rhizophoraceae	2 (2)
Rosaceae	78 (70)
Rubiaceae	280 (298)
Rutaceae	42 (41)
Salicaceae	8 (6)
Sapindaceae	64 (65)
Sapotaceae	41 (34)
Saxifragaceae	11 (8)
Scrophulariaceae	86 (93)
Simaroubaceae	14 (13)
Solanaceae	150 (172)
Staphyleaceae	4 (4)
Sterculiaceae	34 (28)
Styracaceae	4 (3)
Symplocaceae	11 (10)
Tamaricaceae	2
Theaceae	15 (8)
Theophrastaceae	4 (6)
Thymelaeaceae	8 (9)
Tiliaceae	41 (25)
Tovariaceae	1 (1)
Trigoniaceae	2 (2)
Triuridaceae	(3)
Tropaeolaceae	2 (2)
Turneraceae	10 (7)
Typhaceae	3 (2)
Ulmaceae	10 (10)
Urticaceae	47 (55)
Valerianaceae	14 (12)
Verbenaceae	90 (78)
Violaceae	29 (23)
Vitaceae	19 (15)
Vochysiaceae	2 (2)
Winteraceae	1 (1)
Xyridaceae	2 (3)
Zingiberaceae	14 (14)
Zygophyllaceae	7 (5)
Total:	8248 (7745)

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DEDICATION

The Flora of Chiapas is dedicated to the memory of Faustino Miranda and to Eizi Matuda both of whom devoted significant portions of their professional lives to the study of the plant life of Chiapas.

FOREWORD

The state of Chiapas has great geographical and vegetational diversity and complexity. It includes the major tropical region of Mexico, and is the meeting ground of southern tropical and northern temperate floras. The peculiar geologic and edaphic conditions of the area have given rise to many endemic species. Dr. Breedlove has undertaken, with the active collaboration of a number of colleagues, the monumental project of compiling and publishing a comprehensive account of all of the vascular plants known to occur in Chiapas.

A complete flora of Chiapas has not been produced before, although botanical investigations date back to those of Mociño in 1796 and 1798. Paul C. Standley's *Trees and shrubs of Mexico,* completed in 1926, provides some information about woody plants, but to that date collections were few, and large areas of the state remained unsampled. In 1952 Dr. Faustino Miranda, a distinguished botanist and personal friend, published *La vegetación de Chiapas,* but his untimely death in 1964 prevented the completion of his projected more-ambitious work on the woody-plant flora of southwestern Mexico. Dr. Eizi Matuda collected in several areas of the state between 1935 and 1949, with occasional trips after that, and published two lists of the plants he found. There were many earlier investigators—Hartweg, Ghiesbreght, Rovirosa, the Selers, Nelson, Goldman, Purpus, and others.

Dr. Breedlove commenced ethnobotanical studies in Chiapas in 1964, and the lack of adequate references about the plants was immediately apparent. This he decided to correct, and since then he has spent five years in Chiapas and has collected forty-five thousand sets of herbarium specimens, more than twice as many as existed when he started his project.

The world's tropical floras are rapidly disappearing, and Chiapas is not exempt from the tragedy. The *Flora of Chiapas* could not have been written many years ago because access to large areas was limited. Now, by the time the project is completed, some vegetational elements Breedlove and his colleagues have studied and recorded will no longer exist. This work will preserve a record that otherwise would be gone.

The *Flora of Chiapas* includes a detailed conspectus of the state's vegetation types as well as a complete list of their species. It is a well-documented flora, which is uncommon for a tropical area.

George E. Lindsay, *Director*
California Academy of Sciences

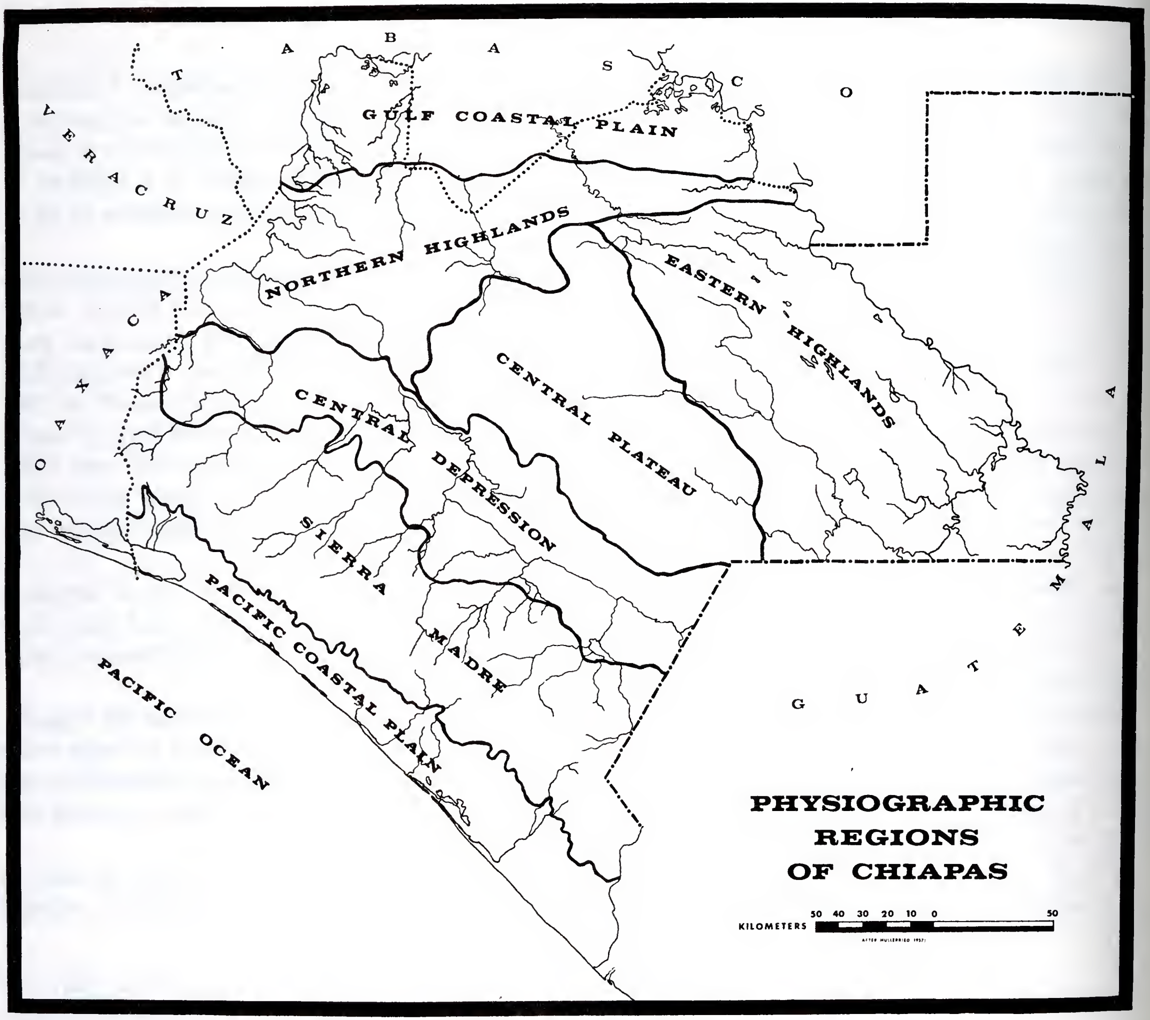

FIGURE 1. Map of the state of Chiapas with outlines of the physiographic regions.

INTRODUCTION TO THE FLORA OF CHIAPAS

Dennis E. Breedlove

Department of Botany, California Academy of Sciences
Golden Gate Park, San Francisco, California 94118

This volume begins the publication of the *Flora of Chiapas,* a work with which I have been involved for sixteen years and which will require at least as many more to complete. We plan that the *Flora* will be a comprehensive treatment, with keys to and descriptions of all of the vascular plants, native and introduced, which occur in the state of Chiapas. We hope that the information contained in the *Flora of Chiapas* will be of use to the people of Mexico, particularly those of Chiapas, and to the broader scientific community as well.

Chiapas, the southernmost state of Mexico, is situated on the Pacific Coast between the border with Guatemala and the Isthmus of Tehuantepec, and occupies more than 74,000 sq km (Helbig, 1964b; Garcia Soto, 1970). The present population of Chiapas is nearly 2,000,000, and almost one-half are Mayan agriculturalists living in dispersed hamlets. The climate and geography is diverse, ranging from semi-desert to rainforest, and elevations are from sea-level with stands of mangroves and coastal strand to peaks as high as 4000 m with subalpine vegetation. The annual rainfall varies from under 750 mm in some localities to over 5000 mm in others. Mean annual temperature ranges from near 12°C on the higher peaks of the Sierra Madre and Central Plateau to about 28°C on the Pacific Coastal Plain (García, 1965, 1973). There are two large river systems in the state (Grijalva and Usumacinta) which together account for almost one-third of the freshwater resources of Mexico (Benassini, 1968).

PHYSIOGRAPHIC REGIONS OF CHIAPAS

Chiapas has one of the most diverse and largest floras of the Mexican states. The study of this vegetation is facilitated by reference to the seven physiographic regions outlined by Müllerried (1957) (see Fig. 1). These regions have consistently similar and distinctive floristic associations. Three of them, the Central Highlands, the Central Depression, and the Northern Highlands, are restricted to Chiapas, but the Sierra Madre and the Eastern Highlands extend southward into Guatemala, while the Pacific and Gulf coastal plains are southern extensions of large central-Mexican regions. Many of the floristic associations in Chiapas are unique and without widespread relationships. These associations are best studied region by region in that many local endemics are restricted to a particular plant association within a particular physiographic region. The regions and the plant associations found within them are:

(1) *The Pacific Coastal Plain* (Planicie Costera del Pacifico: Müllerried, 1957).—This region, a narrow strip of metamorphic strata and intrusive rocks of Precambrian and Paleozoic age with several ranges of low hills, is flat and relatively dry in the north and hilly and wet in the south. Mangrove swamps and patches of coastal strand form a continuous band along the Pacific Ocean. Tropical Deciduous Forest, Palm Forest, Thorn Woodland, and Short-tree Savanna are common in the remaining inland areas. Evergreen and Semi-evergreen Seasonal Forest occurs most abundantly in the southern portion of the coastal plain. The plant associations of this region are widespread types scattered along the Pacific Coast from Sinaloa to Panama (Standley, 1920). There appear to be very few endemic species.

(2) *The Sierra Madre de Chiapas* (Sierra Madre: Müllerried, 1957).—Parallel to the coast from the southern end of the Isthmus of Tehuantepec and extending through Chiapas into Guatemala is a narrow steep range of volcanic mountains ranging in elevation from 1500 m in the north to 4000 m on the Guatemalan border. Tropical Deciduous Forest is common at lower elevations on both escarpments, especially in the north, while Evergreen Seasonal Forest is restricted to riparian situations in the north, and to middle elevations of both escarpments. Lower Montane Rain Forest is found only on the lower slopes of Volcán Tacaná in the Soconusco district. Most of this Pacific

rainforest has been destroyed or altered for cultivation of coffee. Pine-Oak Forest is widespread at middle and higher elevations in the north, but is replaced by Pine-Oak-*Liquidambar* Forest, Montane Rain Forest, and Evergreen Cloud Forest in the south. There are many local endemics in this region, especially in the higher-elevation associations about Volcán Tacaná.

(3) *The Central Depression* (Depresión de Chiapas: Müllerried, 1957; Valle Central: Helbig, 1964a, 1964b; Depresión Central: Miranda, 1952; Rzedowski, 1965).—Beginning with the fast moving streams flowing out of the Cuchumatan Massif, the Río Grijalva descends slowly through a broad, terraced valley from 1200 m elevation at the Guatemalan border to 500 m at the mouth of El Sumidero. This giant basin is characterized by a dry climate (in some places, less than 800 mm annual rainfall). Geologic strata are mostly marine limestones and slates. The depression terminates abruptly where the Grijalva flows into El Sumidero, a sheer-faced canyon with walls up to 1000 m high. This dry valley—Contreras Arias (1955) refers to this area as semi-arid—is more than 200 km long and up to 70 km broad. It is completely surrounded by moist, densely forested mountain areas, affording it complete isolation from other pockets of xeric vegetation. Understandably, there are a large number of endemic plants, especially among the shrubs and small trees occurring on dry, exposed slopes.

The flora of the Central Depression, although xerophytic and containing a number of central Mexican elements, lacks many of the species found in comparable arid habitats of adjacent Oaxaca, even though some of these species occur in the dry regions of eastern Guatemala: *Amphipterygium adstringens* (Schlecht.) Schiede, *Apoplanesia paniculata* Presl, *Megastigma, Myrtillocactus,* and *Plocosperma*. Another interesting facet of the flora of this region is the occurrence of many species known elsewhere only from the dry regions of the Yucatán peninsula (Miranda, 1952).

Most of the Central Depression was probably originally covered with Tropical Deciduous Forest; however, extensive cultivation and grazing has led to large tracts of Thorn Woodland and Savanna. In certain protected riparian areas, Evergreen and Semi-evergreen Seasonal Forest occurs, and Palm Forest is common on alluvial flats in the southern end of the depression.

(4) *The Chiapas Plateau* (also commonly referred to as the Central Highlands [Vogt, 1969], La Meseta Central de Chiapas [Miranda, 1952], Chiapas Highlands [Goldman and Moore, 1945] and Altiplanicie de Chiapas [Müllerried, 1957]).—A highland mass, about 220 km along its principal axis and from 50 to 100 km in width, lies directly east of the Central Depression. It is composed mostly of marine limestones with extrusions of volcanic rocks on the higher peaks (Alencaster, 1971). The broad summit is from 2100 to 2500 m in elevation with a few peaks reaching as high as 2900 m. There is a marked difference in the rainfall between the east and the west escarpments, and the vegetation reflects this difference. Tropical Deciduous Forest and Pine-Oak Forest occur on the drier west side, bordering the Central Depression. Pine-Oak-*Liquidambar* and Montane Rain Forest cover the eastern escarpment. The summits and eastern slopes of the higher peaks and ridges have a diverse Evergreen Cloud Forest which contains a large number of endemic species. Another substantial group of species is restricted to this region and the limestone areas of Huehuetenango, Alta Verapaz, and Baja Verapaz, Guatemala.

The Chiapas Plateau supports a large population of Mayan-swidden agriculturalists. The 1960 census estimated the population size conservatively between 250,000 and 300,000. These people live in a dispersed, "vacant town" manner and cultivate most of the available arable land. As a result, very little primary forest is left.

(5) *The Eastern Highlands* (Montañas del Oriente: Müllerried, 1957).—Eastward from the Central Plateau there are several ranges of steep mountains which gradually slope into the drainage of the Río Usumacinta. The area is mostly limestone with some sandstone and volcanic extrusions. It ranges in elevation from 400 to 1500 m. The vegetation is generally uniform with Lower Montane Rain Forest being most common. There are, however, patches of Short-tree Savanna and Palm Forest scattered throughout the area. Evergreen and Semi-evergreen Seasonal Forest is common in drier situations in the northern portion of the area. Tropical Rain Forest is present in the flat areas surrounding the upper drainage of the Río Usumacinta. Montane Rain Forest is present only on the crests of the highest ridges. Unlike the Central Plateau, this area is very sparsely populated

and large tracts of virgin forest remain. The floristic associations present here are continuous with associations in the Petén region of Guatemala, and the two areas taken together contain many endemic taxa.

(6) *The Northern Highlands* (Montañas del Norte: Müllerried, 1957).—To the north of the Central Plateau and the Central Depression, lie a series of steep ranges of geologically complex volcanic origin. The chasm of the Río Grijalva traverses this area with steep-faced cliffs and high ridges on both sides. An extension of the Sierra Madre, which lies across the border in Oaxaca, bounds it on the north and northwest. Lower Montane Rain Forest occurs along the bases of the ranges while Montane Rain Forest is common on the higher ridges. Pine-Oak-*Liquidambar,* Pine-Oak, and Evergreen and Semi-evergreen Seasonal forests are common in drier situations in temperate and lowland areas, respectively. This region has no major population centers and few roads; much of it can only be reached by footpaths. Understandably, this is the most poorly known of the physiographic regions.

(7) *The Gulf Coastal Plain.*—Two small segments of this large physiographic region are found in the northeast corner of Chiapas. The vegetation is mostly second growth from what once was Tropical Rain Forest or Evergreen and Semi-evergreen Seasonal Forest, but now is Short-tree Savanna and Second-growth Tropical Forest with scattered Palm Forests. Lundell (1942) and Williams (1938, 1939) discuss the plants of part of this area.

Geologically, Chiapas is very dissected. The northeastern half of the state is mostly a thick deposit of marine limestone of Cretaceous to Miocene age. The area on both sides of the Sierra Madre and the entire northwestern part of the Sierra Madre is incredibly fractured exposing Precambrian, Permian, Triassic, Jurassic, and Cretaceous rocks, as well as associated metamorphic strata (Müllerried, 1957). The geology of the southeastern portion of the Sierra Madre is further complicated by the intrusion of recent volcanic activity. This entire area may have been an island or series of islands until the Eocene (Dengo and Bohnenberger, 1969; Dengo, 1973). The Cayman Ridge may have been a land bridge connecting the Guatemala–Chiapas region with the Sierra Maestra of Cuba (Heezen, Dreyfus, and Catalano, 1973) in the Paleocene and Eocene. Tectonically, this region is even more complicated. The southern extent of continental North America is in southern Oaxaca (Raven and Axelrod, 1974, 1975; Dengo, 1973; Kesler and Heath, 1970). The Caribbean plate extends across Guatemala into the southwestern portion of Chiapas via the Cayman trough and the Cuilco-Chixoy-Polochic and Motagua-Jalapa fault zones (Molnar and Sykes, 1969; Kesler, Josey, and Collins, 1970; Malfait and Dinkelman, 1972; Bowin, 1976), but once in Chiapas any clear evidence of this fault is lost. There are thus many confusing possibilities to explain the origin of the terrain of Chiapas. It could be the result of many fractured, small plates (J. Wolfe, 1975, and pers. comm.) or a continental island off the southern tip of North America. Evidences for the origins of the present-day forests that occupy Chiapas are scarce. Obviously, much of the flora is of a recent derivation from the tropical floras of South America (Raven and Axelrod, 1974). However, there were tropical forests widespread in the Eocene (Axelrod, 1966) of North America that were largely eradicated in the severe climatic changes of the Neogene epochs. Some remnants of this North American tropical flora could be preserved in the Montane Tropical Forests of Chiapas, as evidenced by the large number of endemic or restricted genera (*Thornea, Matudea, Steyermarkia, Guamatela,* etc.).

Chiapas is a unique floristic region because it has: (1) the northernmost distribution for a great many Central and South American tropical lowland species and genera; (2) a large number of endemic species that are mostly found in the high-elevation wet forests; (3) a number of species that were thought to be only Guatemalan and are now, through the most recent collections, found to occur in Chiapas; (4) the lowland regions near the Isthmus of Tehuantepec and on the Gulf Coastal Plain, which have a number of species in common with the Yucatán peninsula and the West Indies. Also, Chiapas is the southernmost development of the dry central Mexican Pine-Oak Forest with many of its associated species (Hemsley, 1888; Goldman, 1951).

Figure 2 shows the area of the state covered by tropical and temperate seasonal forests. The lowland Tropical Deciduous Forests and Seasonal Evergreen Forests (up to 1100 m) are composed,

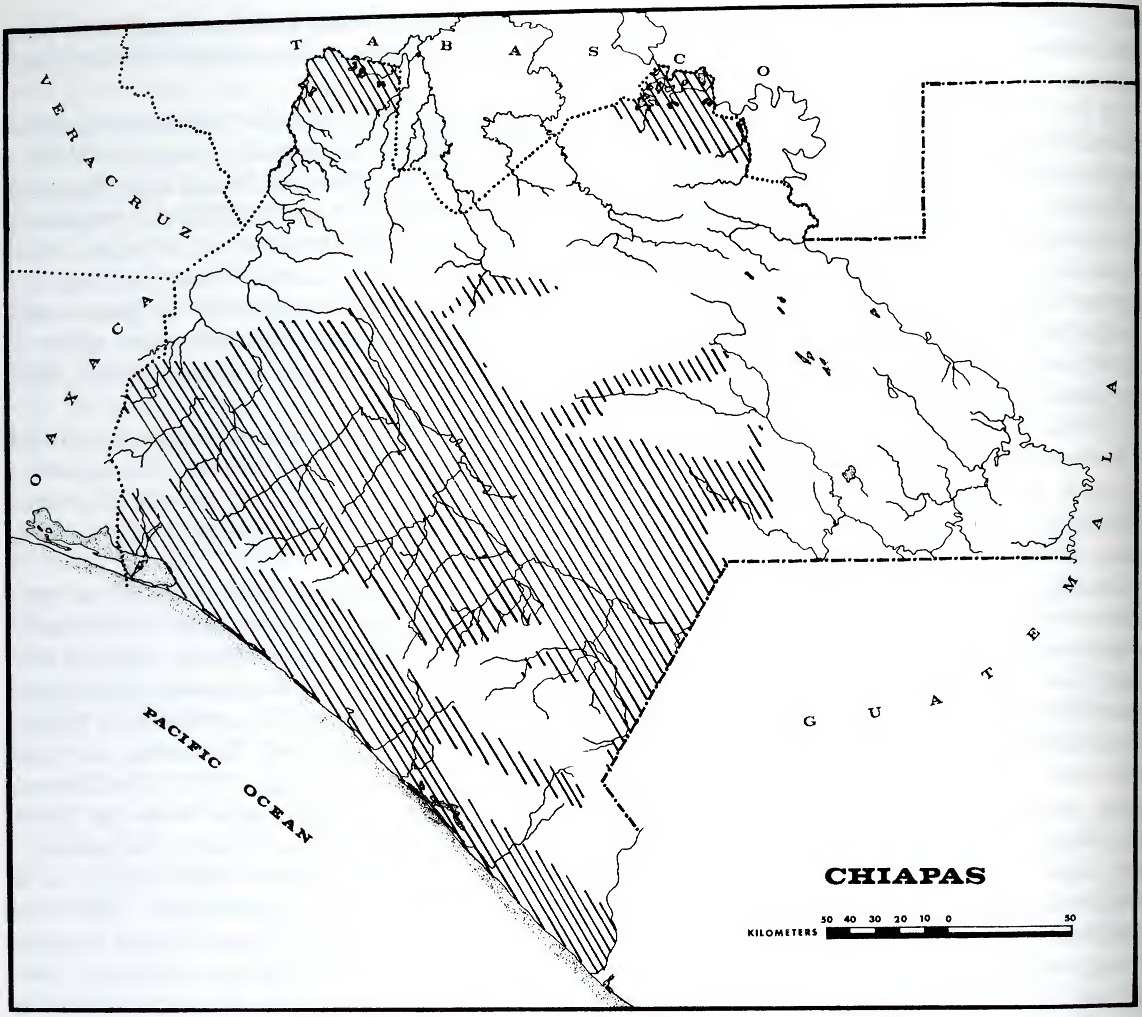

FIGURE 2. Distribution of temperate and tropical seasonal forest types.

in the main, of widespread species which range from as far north as Sinaloa and Tamaulipas to as far south as Panama and South America. The Savannas are similar but also have a large component from Yucatán and the West Indies. The pine and oak forests which are temperate seasonal forests are central Mexican in composition.

Figure 3 shows the distribution of the low-elevation wet tropical forests. The species in these forests are mostly Central American in their distribution, although there are also many endemic species. These forests range north along the east coast of Mexico to Veracruz and south along both coasts to Panama and South America. These are extremely complex communities, and many species of trees are known from only a few collections at widely distant localities. Work in these forests is most urgently needed in that man-related deforestation has the strongest effect here. Much of our understanding of paleodistribution of tropical forests can only come with an as-complete-as-possible understanding of the composition and distribution of the elements in these forests. These are the most diverse in the state with perhaps 1500 species of trees found within its boundaries.

Figure 4 delimits the distribution of high-elevation wet tropical forests (1500–3000 m and up). Like their lowland counterparts, they are Central American in their relationship and are most similar to the cloud forests of Guatemala and Honduras, but have many locally restricted species. Some of the plants involved also occur in similar forests to the north in the Mexican states of Oaxaca and Guerrero.

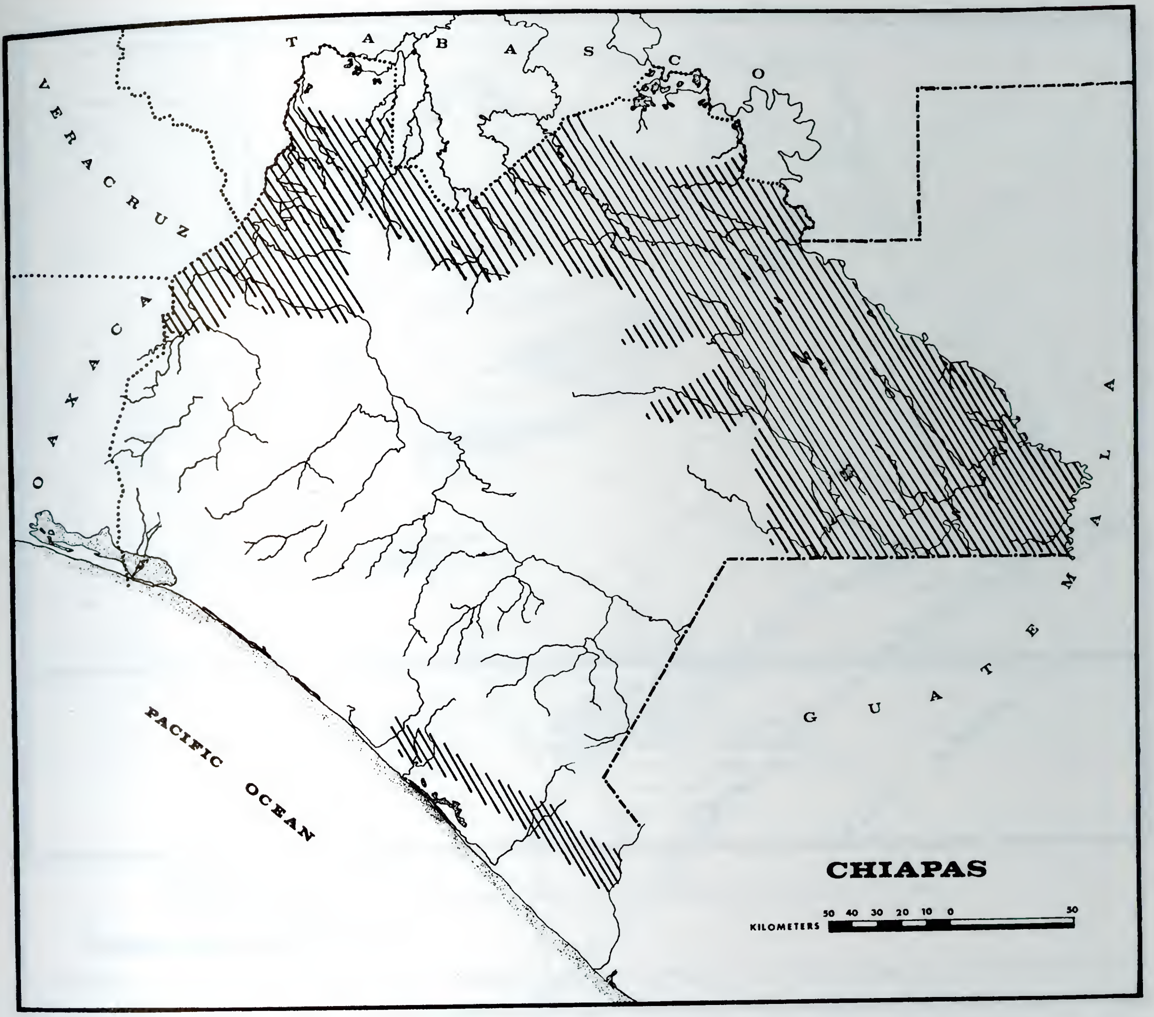

FIGURE 3. Distribution of lowland wet tropical forest types.

These maps show distributions as they were in the primeval state. Chiapas forests have had a long history of human utilization, and the actual area now occupied by forests is much smaller. The reduction of forests has been greatly accelerated in the past 25 years. The last great forest areas are now in the Selva Lacandona and correspond roughly to the large lowland wet forest marked on Figure 3 in the northeastern portion of the state (Duby, 1944; Lundell, 1942).

The total number of species of vascular plants presently recorded from the state is near 8200. They are listed by family on the inside cover with the number of species listed for Guatemala for comparison. This is a preliminary list, and the number of species for the state probably will climb to between 9000 and 10,000 by the time the entire flora is published.

VEGETATIONAL FORMATIONS OF CHIAPAS

The classification of the vegetational formations used in this account is patterned after the one established by Beard (1944), with modifications and additions to better describe the formations as they occur in Chiapas. None of the available treatments of vegetation types of Mexico applicable to Chiapas (Miranda, 1952; Miranda and Hernández X., 1963; Wagner, 1964; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Flores et al., 1971; Rzedowski, 1978) adequately take into account Beard's Formation Series concept, which is essential to the classification presented here

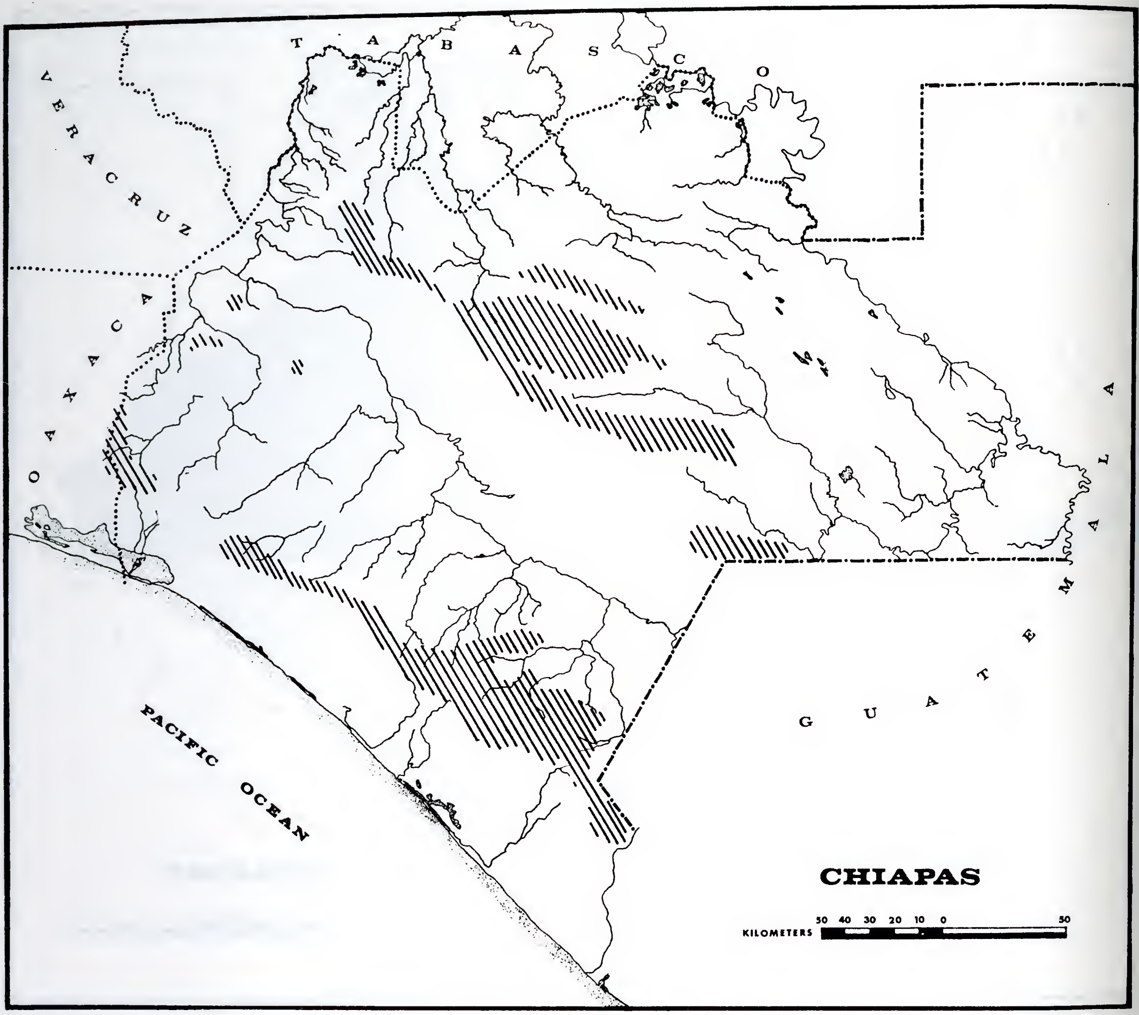

FIGURE 4. Distribution of highland wet tropical forest types.

and gives the simplest, most easily understood terminology for the tropical forest types of Chiapas. Where it is possible and clearly understandable, the forest types of Chiapas referred to by other authors are listed after the appropriate formations. A special effort has been made to include the range of Holdridge Life Zone terms (Holdridge, 1967; Holdridge et al., 1971) applicable to each formation. There are special problems in applying this excellent world-scope system to the vegetation of Chiapas (e.g., no climatic data from locations over 2700 m) despite the tropical nature and aspect of the vegetation, the entire state is technically subtropical (in that it lies above lat. 14°N). Thus, the vegetative units used and defined in this study are solely intended to provide a single consistent set of terms referring to the vegetational forms of Chiapas.

The formations of Chiapas are arranged into four formation-series and are listed diagrammatically (Fig. 5). Second-growth formations will be discussed briefly at the end. Optimum formations occur on well-drained lands and have a habitat characterized by significant precipitation in every month of the year. The four formations in this series can be arranged on an altitudinal gradient from 300 to 3500 m and have broad areas of intergradation between them. Seasonal formations also occur on well-drained lands but have a habitat characterized by alternate wet and dry seasons with the dry period lasting between two and six months. The four lowland formations in this series can be arranged on a gradient of increasing aridity and contain broad areas of intermediate forests. The

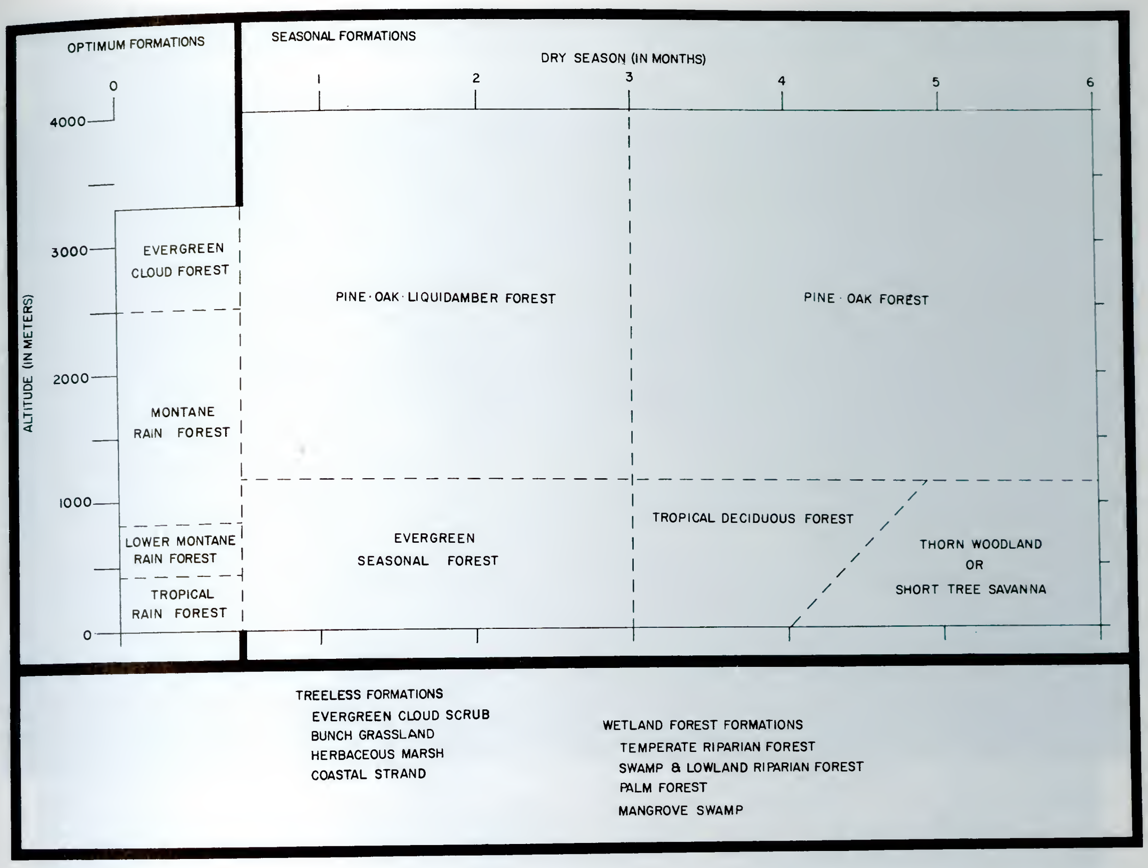

FIGURE 5. Diagrammatic representation of the vegetational formations of Chiapas.

two highland formations are also in response to greater aridity. The remaining two formation-series are admittedly convenient, artificial groupings and share only physiognomy in the case of the treeless formations and standing water in the wet-land forest formations. The formations within these series have little or no floristic relationships and are for the most part locally distributed and dependent on some special feature of the environment.

OPTIMUM FORMATIONS

These four formations are all similar physiognomically, being composed of many layers of evergreen trees and having abundant epiphytes and lianas. A dry season is absent or at most only a few weeks in length, and the forest floor never dries out. Deciduous-leaved trees are uncommon and mostly occur in the zones of intergradation with seasonal formations. Between one-fifth and one-fourth of the forest area of Chiapas is covered with an optimum formation.

(1) *Tropical Rain Forest* (Selva Alta Siempre Verde in part: Miranda, 1952, 1957; Selva Alta Perennifolia in part: Miranda and Hernández X., 1963; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Flores et al., 1971; Bosque Tropical Perennifolio in part: Rzedowski, 1978; Tropical rain forest: Holdridge, 1967) (Fig. 6).—Only in a few locations in the valleys bordering the Río Usumacinta does a forest occur of the proportions great enough to be called Tropical Rain Forest. Here the forest is three-storied with the uppermost story composed of trees with straight, unbranched, buttressed trunks rising as much as 50–60 m from the forest floor (Miranda, 1961). The second story forms a continuous canopy and is between 25 and 40 m tall. The third story is composed of branched small trees from 10 to 20 m tall. Small shrubs and herbaceous cover are practically absent and epiphytes are only in the upper stories. These forests are completely sur-

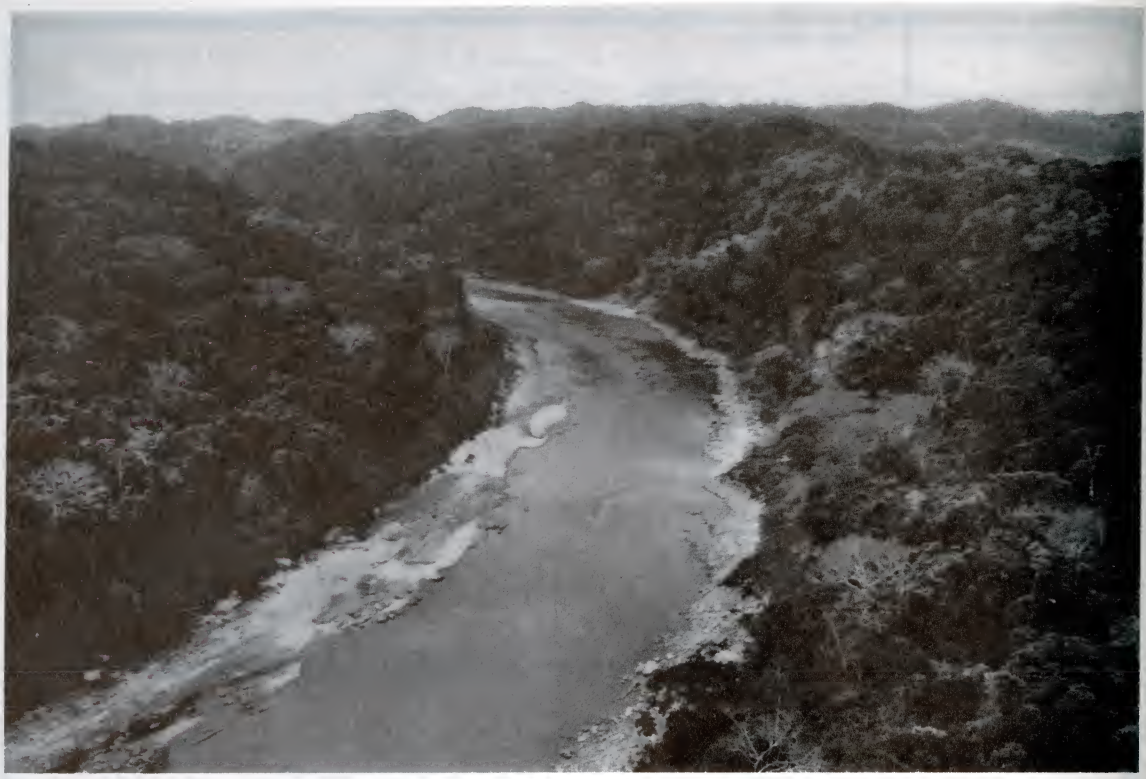

FIGURE 6. Tropical Rain Forest along Río Usumacinta near Yaxchilán.

rounded by Lower Montane Rain Forest, and intergrade into it. Some of the most common canopy trees include: *Aspidosperma megalocarpon* Muell. Arg., *Brosimum alicastrum* Sw., *Dialium guianense* (Aubl.) Sandw., *Erblichia xylocarpa* Standl. & Steyerm., *Ficus* spp., *Guatteria anomala* R. E. Fries, *Manilkara achras* (Mill.) Fosberg, *Poulsenia armata* (Miq.) Standl., *Protium copal* (S. & C.) Engl., *Swietenia macrophylla* King, *Talauma mexicana* (DC.) Don, *Terminalia amazonia* (Gmel.) Exell, *Vatairea lundellii* (Standl.) Killip. The understory trees and the lower trees of the canopy that are most abundant are: *Alchornea latifolia* Sw., *Alibertia edulis* (L. Rich.) A. Rich. ex DC., *Belotia campbellii* Sprag., *Blepharidium mexicanum* Standl., *Bumelia persimilis* Hemsl., *Bursera simaruba* (L.) Sarg., *Cassia grandis* L.f., *Cephaelis tomentosa* (Aubl.) Vahl, *Dracaena americana* Donn.-Smith, *Forchhammeria trifoliata* Radlk., *Guarea excelsa* H.B.K., *Hasseltia dioica* (Benth.) Sleumer, *Hirtella racemosa* Lam., *Lacistema aggregatum* (Berg) Rusby, *Licaria peckii* (I. M. Johnst.) Kosterm., *Orthion subsessile* (Standl.) Standl. & Steyerm., *Ouratea lucens* (H.B.K.) Engler, *Piper* spp., *Pithecellobium arboreum* (L.) Urb., *Quararibea funebris* (La Llave) Visch., *Sickingia salvadorensis* (Standl.) Standl., *Wimmeria bartlettii* Lundell, *Zuelania guidonia* (Sw.) Britt. & Millsp.

(2) *Lower Montane Rain Forest* (Selva Alta Siempre Verde in part: Miranda, 1952, 1957; Selva Alta Perennifolia in part: Miranda and Hernández X., 1963; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Flores et al., 1971; Bosque Tropical Perennifolio in part: Rzedowski, 1978; Tropical Premontane moist, wet, or rain forest: Holdridge, 1967) (Fig. 7).—Inasmuch as most of Chiapas is mountainous, this formation is much more common than Tropical Rain Forest. Most of the Eastern Highlands and large sections of the Northern Highlands along with a narrow band on the western base of the Sierra Madre are covered with this formation. The Sierra Madre forests have been cut or altered for the production of coffee, while those of the Eastern and Northern highlands remain mostly virgin.

This formation is physiognomically similar to Tropical Rain Forest but lacks the uppermost story extending above the canopy. The canopy layer is 25–45 m high. Lianas and epiphytes are much

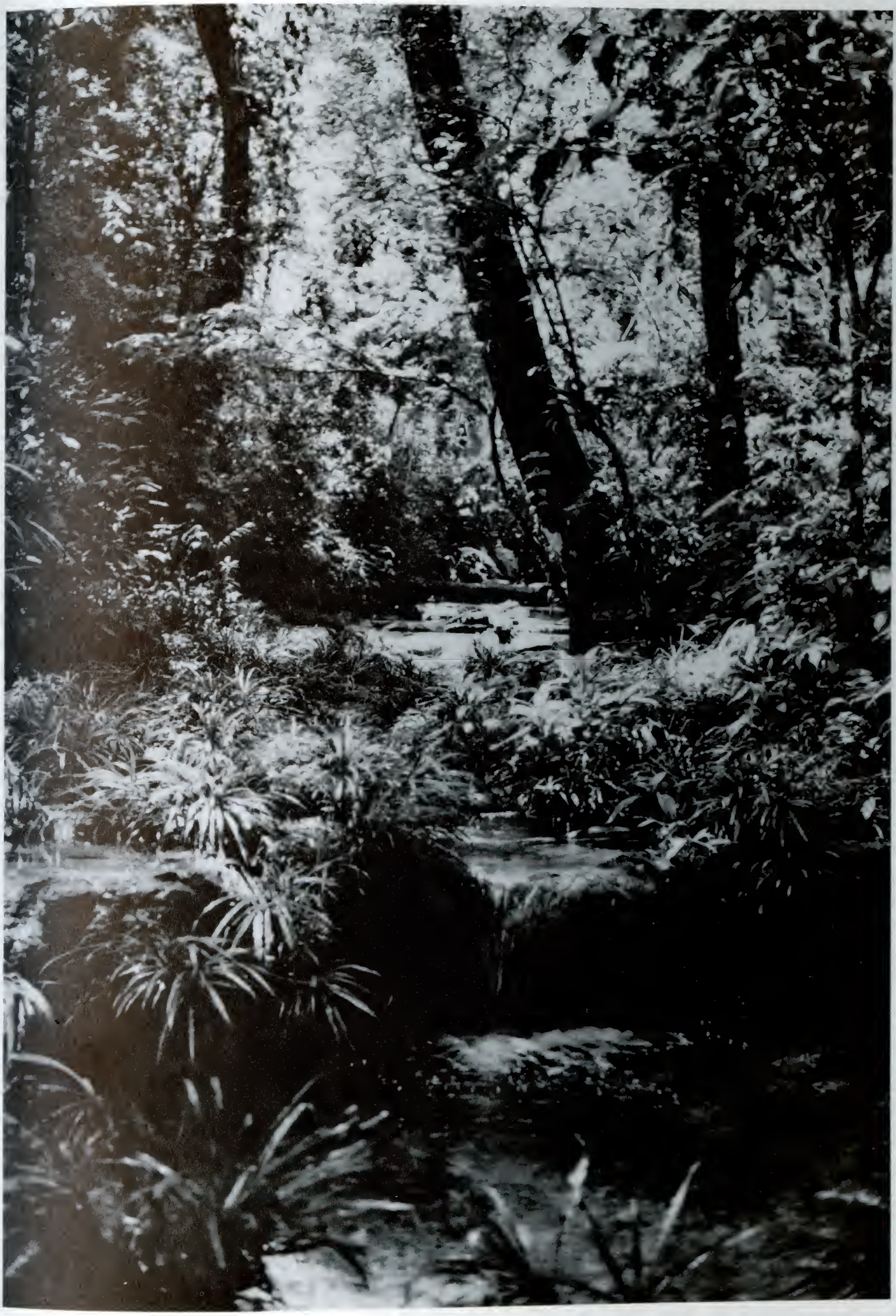

FIGURE 7. Lower Montane Rain Forest near Palenque.

more common and epiphytes are spread throughout all of the forest layers. The forest floor is covered with a dense thicket of spinescent-palms, cycads, low-branched shrubs and lianas making travel on anything but established trails impossible. Most of the canopy and understory trees present in the Tropical Rain Forest are present here. There are many additional species, including the following canopy trees: *Alseis yucatanensis* Standl., *Belotia mexicana* (DC.) Schum., *Calophyllum brasiliense* Camb., *Chaetoptelea* (*Ulmus*) *mexicana* Liebm., *Licania platypus* (Hemsl.) Fritsch, *Nectandra sinuata* Mez, *Ocotea rubriflora* Mez, *Quercus oleoides* S. & C., *Quercus skinneri* Benth., *Sebastiana longicuspis* Standl., *Talauma mexicana* (DC.) Don, and *Vochysia hondurensis* Sprag.

Some of the more common understory and canopy trees include in addition to those cited for Tropical Rain Forest: *Chrysophyllum mexicanum* Brandeg., *Cleidion oblongifolium* (Standl.) Croizat, *Cymbopetalum penduliflorum* (Dunal) Baill., *Faramea occidentalis* (L.) A. Rich., *Piper* spp., *Pseudolmedia spuria* (Sw.) Griesb., *Rhacoma eucymosa* (Loes. & Pitt.) Standl., *Rinorea guatemalensis* (Wats.) Bartl., *Sloanea terniflora* (Moc. & Sessé) Standl., *Stemmadenia donnell-smithii* (Rose) Woods., and *Trophis racemosa* (L.) Urb.

(3) *Montane Rain Forest* (Selva Mediana y Baja Siempre Verde, in part: Miranda, 1952, 1957; Selva Mediana o Baja Perennifolia, in part: Miranda and Hernández X., 1963; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Bosque Tropical Perennifolio in part: Rzedowski, 1978; Tropical montane moist, wet, rain forest: Holdridge, 1967) (Fig. 8).—This formation, composed of three or sometimes two layers of trees and a dense shrubby understory, occurs along the upper slopes and crests of all the ridges in the Eastern and Northern highlands, along the eastern escarpment of the Central Highlands, and along both slopes of the southern part of the Sierra Madre. Epiphytes, including a profusion of mosses, are characteristic of all levels of this formation. Epiphytic ferns, orchids, bromeliads, aroids, and many other groups are best developed here of all forest formations. Herbaceous plants are common on the forest floor. Montane Rain Forest can occur between 900 and 2200 m and is often associated with steep slopes. The canopy is not nearly as continous as that of Lower Montane Rain Forest and is often only 25–35 m high, although occasional taller trees are commonly encountered. The second layer is composed of shrubs and small trees between 5 and 15 m tall. This forest association reaches its northern limit in western Mexico in the mountains of southern Oaxaca near the Chiapas border (MacDougall, 1971); however, on the eastern slope it is found as far north as Tamaulipas (Rzedowski, 1963). The more common trees of the canopy layer are: *Alfaroa mexicana* Stone, *Ardisia alba* Lundell, *Brunellia mexicana* Standl., *Calatola laevigata* Standl., *Hedyosmum mexicanum* Cordemoy, *Hyperbaena mexicana* Miers, *Lunania mexicana* Brandeg., *Matudea trinervia* Lundell, *Meliosma matudae* Lundell, *Mirandaceltis monoica* (Hemsl.) Sharp, *Mosquitoxylon jamaicense* Krug & Urban, *Nectandra reticulata* (R. &. P.) Mez, *Oecopetalum mexicanum* Greenm. & Thoms., *Oreopanax sanderianus* Hemsl., *Oreopanax xalapensis* (H.B.K.) Dcne. & Planch., *Quercus oocarpa* Liebm., *Quercus peduncularis* Nee, *Platanus chiapensis* Standl., *Synardisia venosa* (Mast.) Lundell, *Trichilia erythrocarpa* Lundell, *Turpinia occidentalis* Don. The more common trees and shrubs of the understory are: *Acalypha skutchii* I. M. Johnst., *Billia hippocastanum* Peyr., *Centropogon cordatus* Benth., *Cephaelis axillaris* Sw., *Cephaelis elata* Sw., *Chamaedorea concolor* Mart., *Eugenia ravenii* Lundell, *Hampea longipes* Miranda, *Miconia lauriformis* Naud., *Mollinedia guatemalensis* Perk., *Oreopanax liebmanii* Marchal, *Palicourea* spp., *Parathesis microcalyx* Donn.-Smith, *Psychotria* spp., *Siparuna nicaraguensis* Hemsl., *Trophis mexicana* (Liebm.) Bur., *Urera alceifolia* Gaud.

(4) *Evergreen Cloud Forest* (Cloud Forest in part: Leopold, 1950; Selva Mediana y Baja Siempre Verde, in part: Miranda, 1952, 1957; Selva Mediana o Baja Perennifolia, in part: Miranda and Hernández X., 1963; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Subtropical montane wet or rain forest: Holdridge, 1967) (Fig. 9).—This formation consists of one to two layers of closely spaced trees and a dense shrubby understory. The canopy can be as tall as 40 m with straight smooth trunks in protected locations, but it is often much lower, especially on windswept ridges where it resembles the Elfin Woodland described by Beard (1944). It must be emphasized that this formation shares many of the physiognomic aspects of wet tropical forest formations from lower elevations, i.e., buttressed trees; dense continuous canopy; and trees with broad, leathery, evergreen leaves. Tree ferns are most common here, although they also occur in Montane and Lower

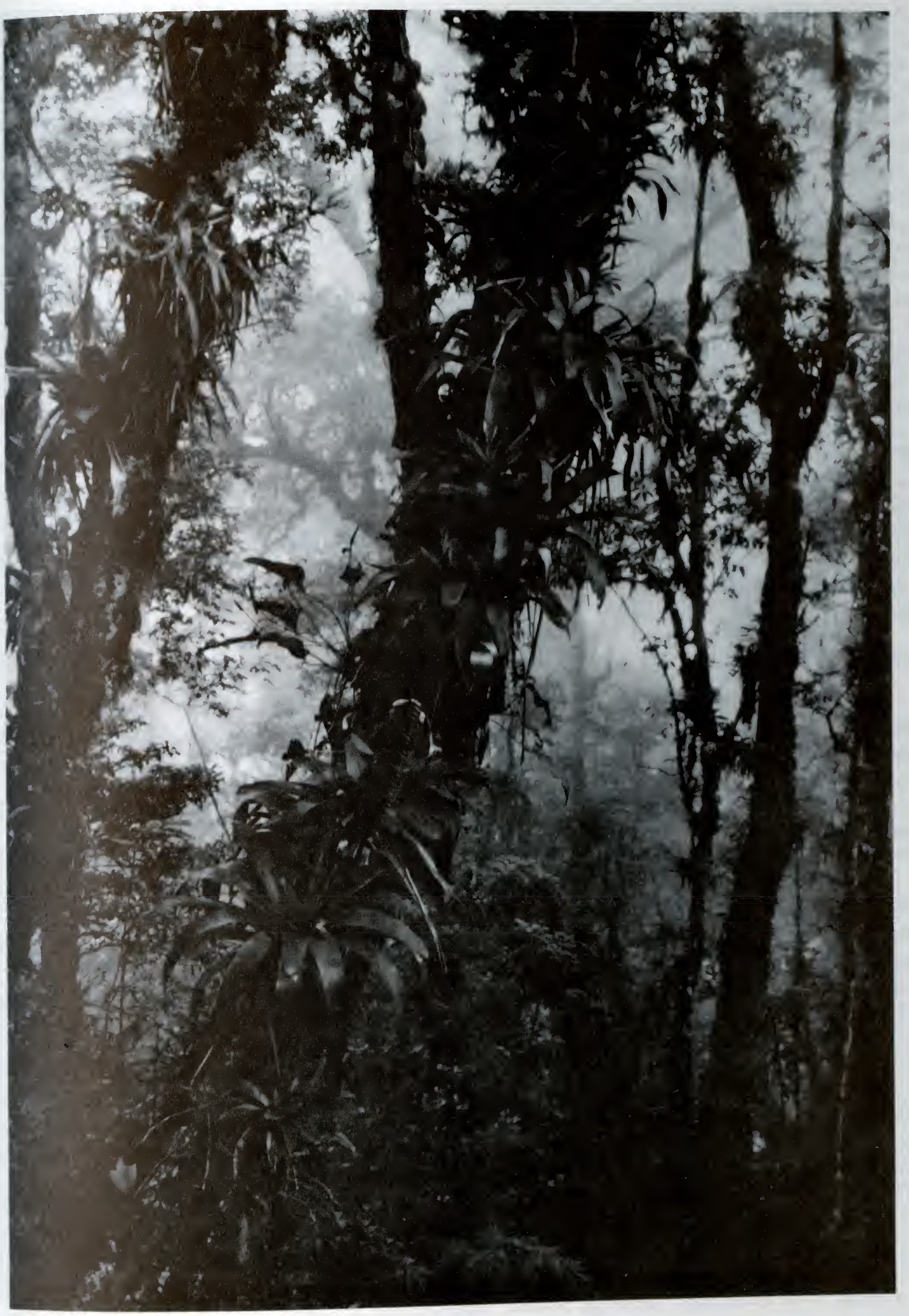

FIGURE 8. Montane Rain Forest above Rayón.

Montane rain forests. There are a great many narrowly endemic species that occur in one or more of the scattered locations for this formation. Well-developed examples of this forest are scarce and rapidly disappearing due to the pressures of man. At present it occurs only about the crests of the highest peaks of the Central Highlands between 2000 and 2900 m and also in the Sierra Madre between 1900 and 3200 m. Lianas are almost completely absent in this formation; herbaceous vines, however, are abundant. Epiphytic angiosperms such as orchids and bromeliads are uncommon and limited to a few species. Mosses hang in sheafs from the branches and epiphytic ferns are common. Fog and clouds seem always to be hanging over these forests and account for much of the precipitation that falls here. Frost is common in January on cleared or exposed land adjacent to these forests, although the temperature rarely, if ever, drops to 0°C on the forest floor. Common trees of the canopy are: *Abies guatemalensis* Rehder, *Acer negundo* L., *Chiranthodendron pentadactylon* Larreatequi, *Clethra lanata* Mart. & Gal., *Clethra oleoides* Wms., *Drimys granadensis* L., *Magnolia sharpii* Miranda, *Meliosma matudae* Lundell, *Microtropis contracta* Lundell, *Olmediella betschleriana* (Goepp.) Loes., *Oreopanax capitatus* (Jacq.) Dcne. & Planch., *Persea donnell-smithii* Mez ex Donn.-Smith, *Persea schiedeana* Nees, *Photinia matudae* Lundell, *Pinus ayacahuite* Ehrenb., *Podocarpus matudae* Lundell, *Quercus acatenangensis* Trel., *Quercus benthami* A. DC., *Quercus crispifolia* Trel., *Quercus hondurensis* Trel., *Weinmannia pinnata* L., *Wimmeria chiapensis* Lundell, *Zinowiewia rubra* Lundell. Common shrubs of the understory include: *Cavendishia crassifolia* (Benth.) Hemsl., *Cleyera theaeoides* (Sw.) Choisy, *Deppea grandiflora* Schlecht., *Eugenia tonii* Lundell, *Fuchsia microphylla* subsp. *aprica* (Lundell) Breedl., *Fuchsia paniculata* Lindl., *Gentlea micrantha* (Donn.-Smith) Lundell, *Greigia oaxacana* L. B. Smith, *Mahonia paniculata* Forst., *Miconia ravenii* Wurdack, *Rapanea juergensenii* Mez, *Saurauia oreophila* Hemsl., *Symplocos breedlovei* Lundell, *Vaccinium confertum* H.B.K., *Viburnum blandum* Morton.

SEASONAL FORMATIONS

Well over half of the forest area of Chiapas consists of seasonal formations which are diverse physiognomically but are floristically related and form bands of intergradation. Characteristically, they are open forests without a closed canopy. Some percentage of deciduous trees occur in all of the formations. The forest floor does not have a continuous understory; however, shrubs are common. Lianas are uncommon or totally absent in most of these formations, whereas epiphytic angiosperms are abundant and can become more prominent than in the optimum formations. Epiphytic mosses are poorly represented.

(5) *Evergreen Seasonal Forest* (Selva Alta Subdecidua: Miranda, 1952, 1957; Selva Alta o Mediana Subperennifolia: Miranda and Hernández X., 1963; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Flores et al., 1971; Selva Alta o Mediana Subcaducifolia: Miranda and Hernández X., 1963; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Bosque Tropical Perennifolio in part: Rzedowski, 1978; Tropical or Subtropical or Tropical Premontane, moist forest: Holdridge, 1967) (Fig. 10).—Although often split into two formations (Evergreen and Semi-evergreen seasonal forests), the zones of intergradation are so large as to make the distinction meaningless. This is the first in a transitional series of forest types from Tropical and Lower Montane rain forests to Thorn Woodland. Superficially, it is quite similar to the rain forest formations but differs in having only two and sometimes one layer of trees. The canopy is discontinuous and contains some percentage of deciduous trees, depending on the aridity of the locality. The forest attains a height of 25–35 m. The dry season is very marked, and the forest floor becomes quite dry. There is a great seasonal variation in herbaceous plants. Lianas and epiphytes are usually quite abundant. This formation is common on the western and northeastern slopes of the Sierra Madre (up to 1200 m), in the southern and western portions of the Northern Highlands and on the Gulf Coastal Plain. The gallery forest which occurs along stream channels in regions of dry forest and savanna is an Evergreen Seasonal Forest. Some of the common trees of this formation are: *Astronium graveolens* Jacq., *Bernoullia flammea* Oliver, *Brosimum alicastrum* Sw., *Bumelia persimilis* Hemsl., *Calycophyllum candidissimum* (Vahl) DC., *Ceiba pentandra* (L.) Gaertn., *Coccoloba*

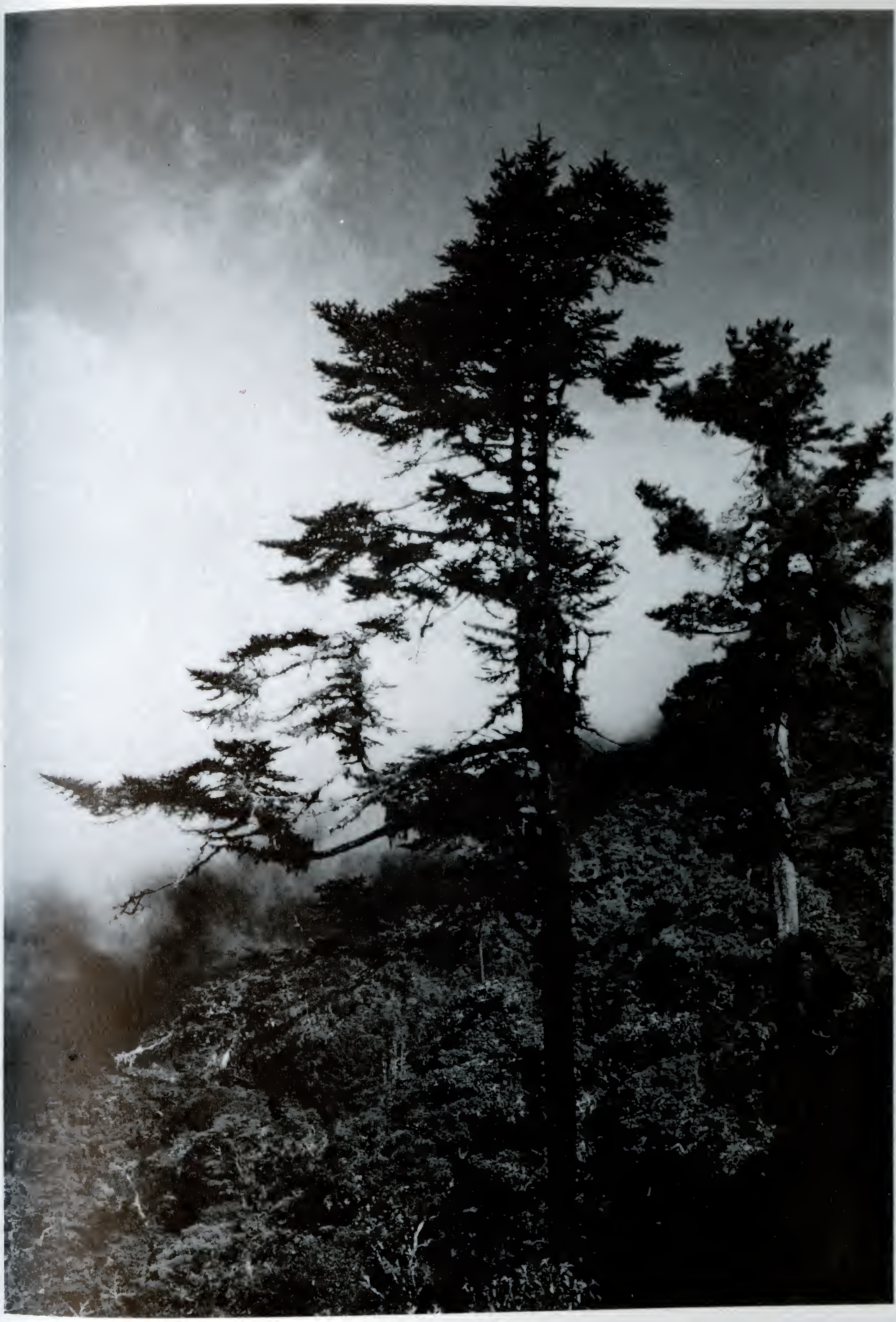

FIGURE 9. Evergreen Cloud Forest with *Abies guatemalensis*, southeast slope of Volcán Tacaná.

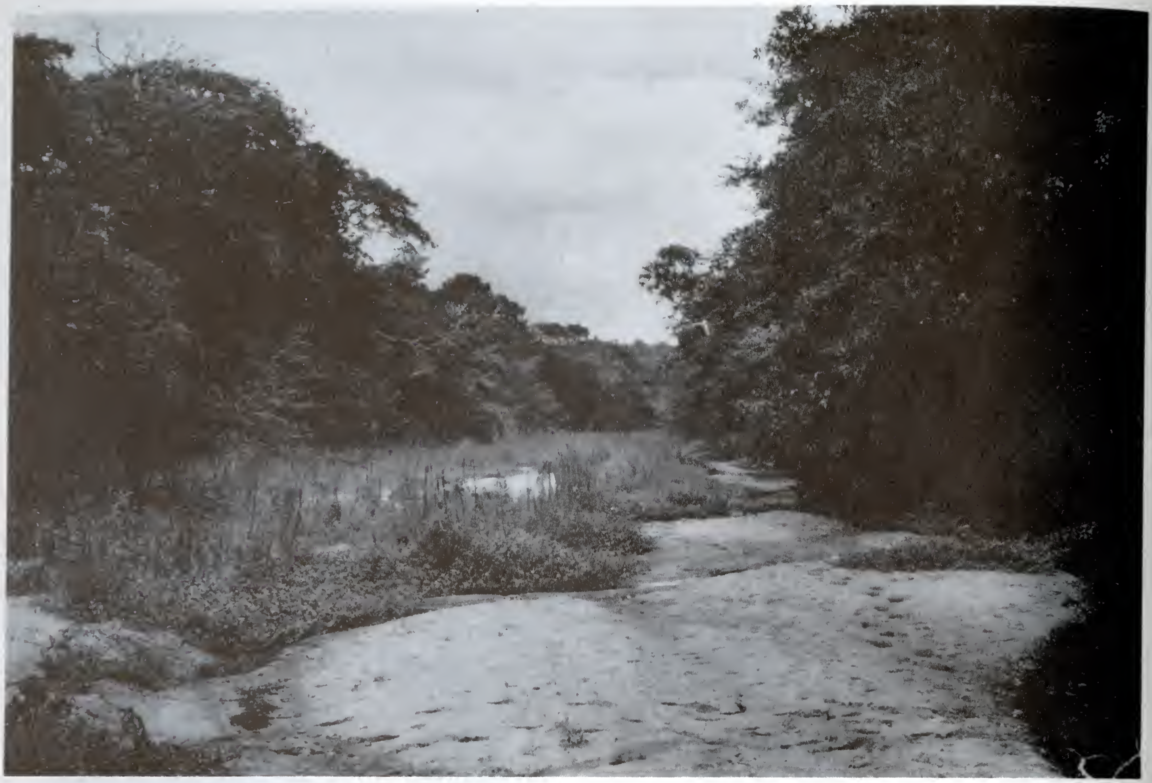

FIGURE 10. Evergreen Seasonal Forest along Río Cintalapa.

barbadensis Jacq., *Cordia alliodora* (R. & P.) Cham., *Cupania dentata* DC., *Elaeodendron trichotomum* (Turcz.) Lundell, *Enterolobium cyclocarpum* (Jacq.) Griseb., *Ficus glaucescens* (Liebm.) Miq., *Guettarda combsii* Urban, *Hymenaea courbaril* L., *Lafoensia punicaefolia* DC., *Licania arborea* Seem., *Platymiscium dimorphandrum* Donn.-Smith, *Rheedia edulis* Triana & Planch., *Sapium macrocarpum* Muell. Arg., *Sterculia mexicana* R. Br., *Styrax argenteus* Presl, *Tabebuia chrysantha* (Jacq.) Nichols., *Vatairea lundellii* (Standl.) Killip. Common shrubs and small trees include: *Amyris chiapensis* Lundell, *Ardisia escallonioides* S. & C., *Bourreria huanita* (La Llave & Lex.) Hemsl., *Calyptranthes chiapensis* Lundell, *Clusia flava* Jacq., *Eugenia acapulcensis* Steud., *Gentlea venosissima* (R. & P.) Lundell, *Karwinskia calderonii* Standl., *Psychotria erythrocarpa* Schlecht.

(6) *Tropical Deciduous Forest* (Deciduous Seasonal Forest: Beard, 1944; Selva Baja Decidua: Miranda, 1952, 1957; Selva Baja Cauducifolia: Miranda and Hernández X., 1963; Pennington and Sarukhán K., 1968; Bosque Tropical Deciduo: Rzedowski and McVaugh, 1966; Rzedowski, 1978; Tropical or Subtropical dry and very dry forest: Holdridge, 1967) (Fig. 11).—This is a diverse association of deciduous and semi-deciduous trees which is common in dry situations from Sonora to Panama. This association is normally between 10 and 20 m high with a dense, thicketlike understory. However, in some protected semi-riparian situations the trees can be as tall as 40–50 m with straight trunks and a low understory. There are many species of trees common in this association, and the dominants vary with the environment of the specific locality. Lianas and epiphytes are present but reduced in number. The dry season is very long (4–6 months) and severe. Almost all of the trees and understory plants lose their leaves. Many trees flower at this time and are quite showy, but the general appearance is of complete dormancy. A few weeks after the rains begin, this once-desert looks like a verdant jungle. Hundreds of species of herbaceous plants sprout and cover the ground, often producing a stand of 1–2 m high. In Chiapas one finds Tropical Deciduous Forest prevalent along the Coastal Plain and the lower hills of the Sierra Madre. It is also common

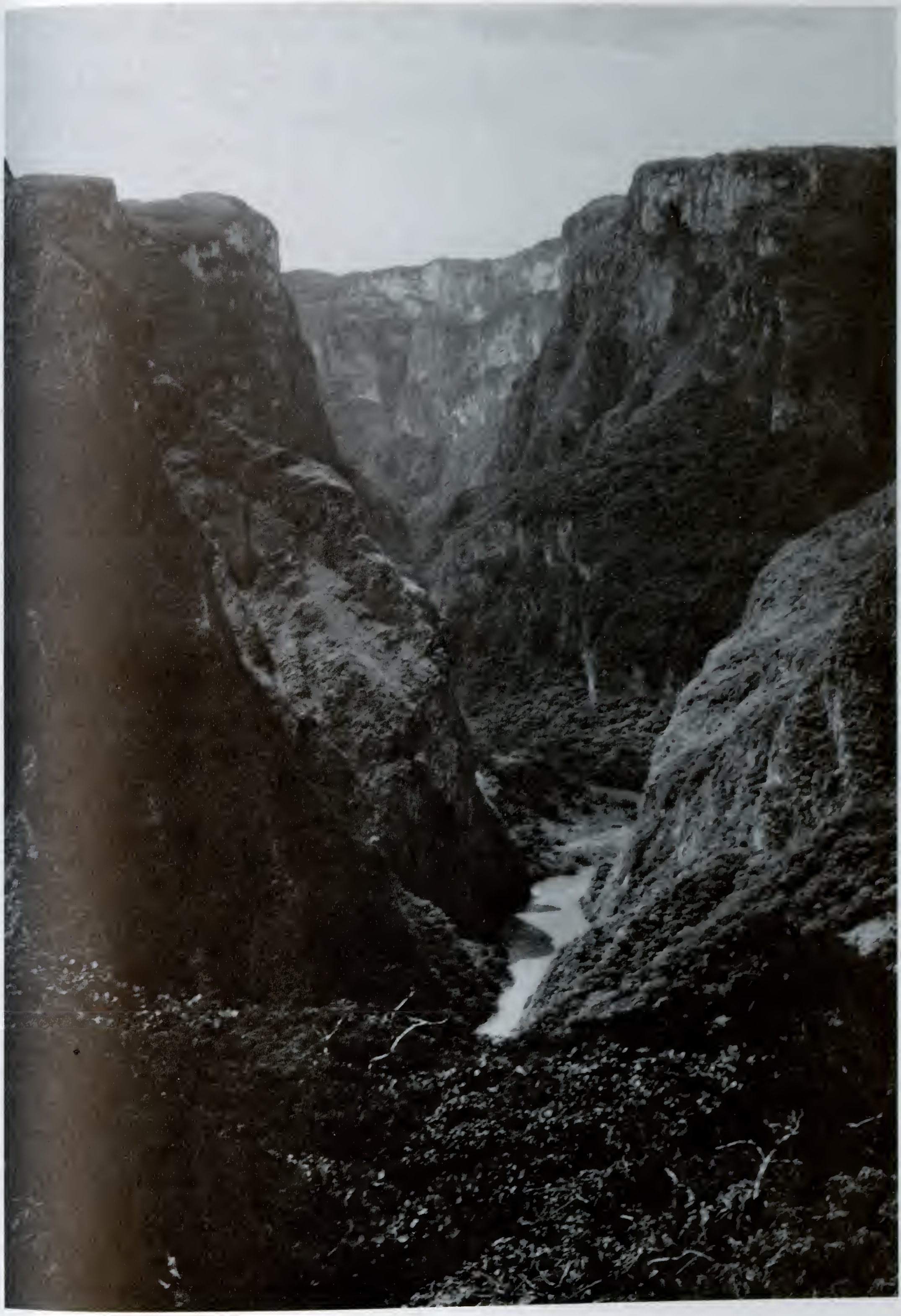

FIGURE 11. Tropical Deciduous Forest at El Sumidero.

throughout much of the Central Depression. Some of the common trees are: *Annona* spp., *Bucida macrostachya* Standl., *Bursera excelsa* (H.B.K.) Engl., *Bursera simaruba* (L.) Sarg., *Calycophyllum candidissimum* (Vahl) DC., *Cecropia peltata* L., *Cedrela oaxacensis* C. DC. & Rose, *Ceiba aesculifolia* (H.B.K.) Britt. & Baker, *Cochlospermum vitifolium* Willd. ex Spreng., *Cordia alliodora* (R. & P.) Cham., *Eysenhardtia adenostylis* Baill., *Gliricidia sepium* (Jacq.) Steud., *Godmania aesculifolia* (H.B.K.) Standl., *Hauya elegans* H.B.K., *Heliocarpus donnell-smithii* Rose, *Hura polyandra* Baill., *Ipomoea murucoides* Roem. & Schult., *Leucaena* spp., *Luehea candida* (DC.) Mart., *Lysiloma aurita* (Schlecht.) Benth., *Plumeria rubra* L., *Pseudobombax ellipticum* (H.B.K.) Dugand, *Spondias mombin* L., *Stemmadenia obovata* (H. & A.) Schum., *Swietenia humilis* Zucc., *Tabebuia chrysantha* (Jacq.) Nichols., *Tabebuia rosea* (Bertol.) DC., *Triplaris melaenodendron* (Bertol.) Standl. & Steyerm.

(7) *Short-tree Savanna* (Sabana: Miranda, 1952, 1957; Miranda and Hernández X., 1963; Gómez Pompa, 1965; Pennington and Sarukhán K., 1968; Selva Baja Subperennifolia: Miranda and Hernández X., 1963; Vegetación Sabanoide: Rzedowski and McVaugh, 1966; Savanna: Beard, 1953; Leopold, 1950; Lundell, 1934, 1937).—Confusion as to the application of the term "savanna" and the questioning of the nature of this type of vegetation concerning whether it represents a climax or a disclimax in response to the activities of man, along with the great variety of associations and situations which fall under this term, has led to my adoption of Short-tree Savanna to refer to a very abundant vegetational association of grassland and spaced low trees usually occurring on shallow, poorly drained soils. It is commonly found on gradual-sloping plains or on flat bottomlands. The trees are low and gnarled, and usually well spaced; they rarely attain a height of more than 20 m. In some situations (described by Miranda and Hernández X., 1963, as Selva Baja Subperennifolia), the trees will form a low forest with a grass understory. Four species of trees, *Byrsonima crassifolia* (L.) DC., *Crescentia cujete* L., *Crescentia alata* H.B.K. and *Curatella americana* L., are the most characteristic of this formation. *Acacia pennatula* (S. & C.) Benth., *Alvaradoa amorphoides* Liebm., *Cordia dodecandra* DC., *Piscidia piscipula* (L.) Sarg., *Quercus oleoides* S. & C., *Tetracera volubilis* L., and occasional species of palms also can be found here, either singly, or in association with the other-mentioned species.

(8) *Thorn Woodland* (Selva Baja Espinosa Cauducifolia: Miranda and Hernández X., 1963; Pennington and Sarukhán K., 1968; Bosque Espinoso: Rzedowski and McVaugh, 1966; Tropical and Subtropical thorn woodland: Holdridge, 1967) (Fig. 12).—This is a dense association of shrubs and low trees which is often quite uniform in appearance. The majority of the species present are armed with an assortment of spines, thorns, and prickles. This formation usually occurs on poor, rocky soils on slopes adjacent to stands of Short-tree Savanna of Tropical Deciduous Forest. Thorn Woodland is poorly developed in Chiapas, limited to the northern parts of the Central Depression and the Pacific Coastal Plain. It is, however, quite prominent in the Isthmus of Tehuantepec, just north of the state line. The more common associates are: *Acacia cochliacantha* H. & B., *Acacia cornigera* (L.) Willd., *Acacia farnesiana* (L.) Willd., *Acacia pringlei* Rose, *Bauhinia pauletia* Pers., *Buettneria aculeata* Jacq., *Bursera diversifolia* Rose, *Casearia nitida* Jacq., *Cordia curassavica* (Jacq.) Roem. & Schult., *Cordia spinescens* L., *Croton guatemalensis* Lotsy, *Diphysa floribunda* Peyr., *Erythroxylon havanense* Jacq., *Jacquinia aurantiaca* Ait., *Karwinskia calderonii* Standl., *Piptadenia flava* Benth., *Pisonia macranthocarpa* Donn.-Smith, *Pithecellobium dulce* (Roxb.) Benth., *Randia aculeata* L., *Sageretia elegans* (H.B.K.) Brongn., *Stenocereus* sp., *Zizyphus amole* (Sesse & Moc.) M. C. Johnst.

(9) *Pine-Oak-*Liquidambar *Forest* (Cloud Forest in part: Leopold, 1950; Martin, 1958; Deciduous Forest: Miranda and Sharp, 1950; Bosque Deciduo: Miranda, 1952; Pine-Oak-*Liquidambar* Forest: Carlson, 1954; Bosque: Miranda, 1957; Bosque Caudúcifolio: Miranda and Hernández X., 1963, Pennington and Sarukhán K., 1968; Flores et al., 1971; Bosque mesofilo de montaña: Rzedowski and McVaugh, 1966; Rzedowski, 1978; Subtropical montane moist forest: Holdridge, 1967) (Fig. 13).—On the moist north and east escarpments of the Central Highlands and at scattered localities in the Northern Highlands and on the eastern escarpment of the Sierra Madre, occurs a diverse association with many species of deciduous and semi-deciduous trees. Epiphytes are very common

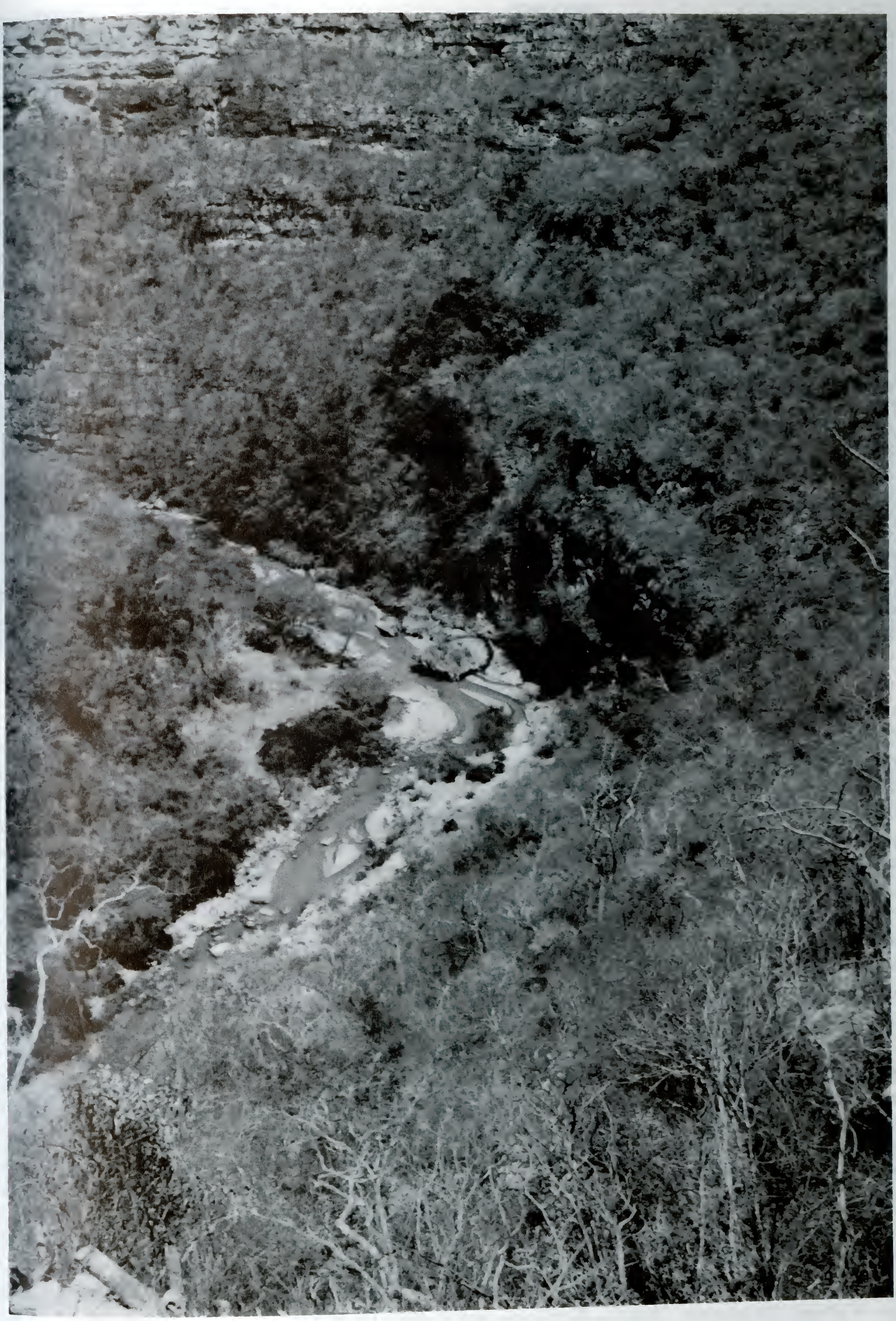

FIGURE 12. Thorn Woodland along the Río de la Venta.

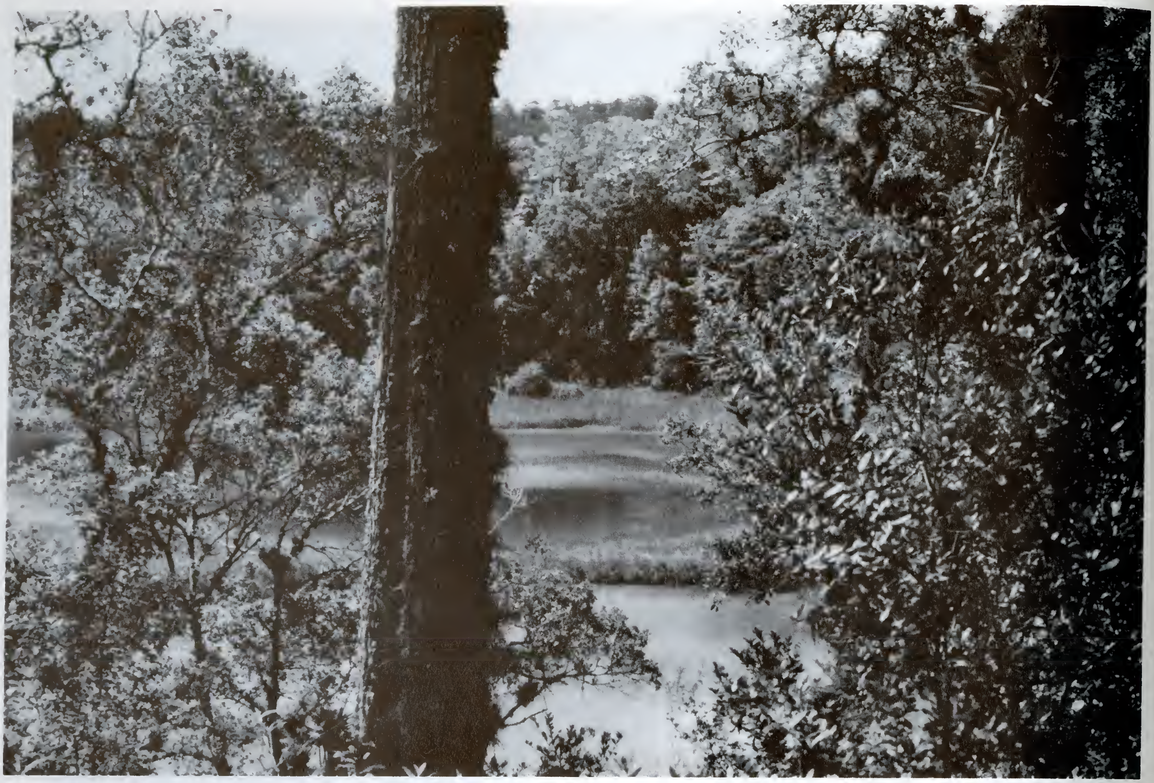

FIGURE 13. Pine-Oak-*Liquidambar* Forest at the Lagos de Monte Bello.

with numerous species, and oaks are often so heavily laden that one can barely see the branches. The understory is variable, ranging from a dense association with many species of shrubs, subshrubs, and vines, to a tall grassy expanse with scattered shrubs. The trees are commonly between 15 and 35 m tall and can be widely spread, but usually are close enough for their crowns to form a continuous canopy. Many of the trees are quite broad-crowned. This association is always diverse, and one never finds pure stands of one or two species. This is a temperate forest quite similar to the diverse hardwood forests of the southeastern United States, and depauperate elements of this association occur at scattered locations in the Sierra Madre of central and northern Mexico as far north as southern Sonora (A. Felger, pers. comm.) in the west and Tamaulipas in the east (Miranda and Sharp, 1950). Some of the common species of trees are: *Carpinus caroliniana* Walt., *Cassia oxyphylla* H.B.K., *Citharexylum donnell-smithii* Greenm., *Clethra suaveolens* Turcz., *Cornus disciflora* DC., *Cupania dentata* DC., *Erythrina chiapensis* Krukoff, *Fraxinus uhdei* (Wenzig.) Lingel, *Liquidambar styraciflua* L., *Meliosma dives* Standl. & Steyerm., *Montanoa hexagona* Rob. & Greenm., *Nyssa sylvatica* Marsh, *Ostrya guatemalensis* (Winkl.) Rose, *Perrottetia ovata* Hemsl., *Pinus chiapensis* (Martinez) Andresen, *Pinus montezumae* Lamb., *Quercus candicans* Nee, *Quercus oocarpa* Schiede, *Quercus polymorpha* S. & C., *Quercus sapotaefolia* Liebm., *Quercus segoviensis* Liebm., *Quercus skinneri* Benth., *Rhus striata* R. & P., *Saurauia scabrida* Hemsl., *Styrax glabrescens* Benth., *Turpinia occidentalis* (Sw.) D. Don. The following shrubs are common in the understory: *Aphelandra gigantiflora* Lindau, *Baccharis trinervis* (Lam.) Pers., *Bocconia gracilis* Hutch., *Cestrum guatemalensis* var. *gracile* Morton, *Fuchsia microphylla* subsp. *quercetorum* Breedl., *Gaultheria odorata* Willd., *Guamatela tuerckheimii* Donn.-Smith, *Hibiscus bifurcatus* var. *pilosus* Gurke, *Liabum glabrum* var. *hypoleucum* Cogn., *Parathesis chiapensis* Fern., *Phenax mexicanus* Wedd., *Rapanea myricoides* (Schlecht.) Lundell, *Rhus terebinthifolia* S. & C., *Solanum brachystachys* Mart. & Gal., *Symplocos longipes* Lundell, *Triumfetta grandiflora* Vahl, *Verbesina perymenioides* Sch. Bip., *Viburnum hartwegii* Benth.

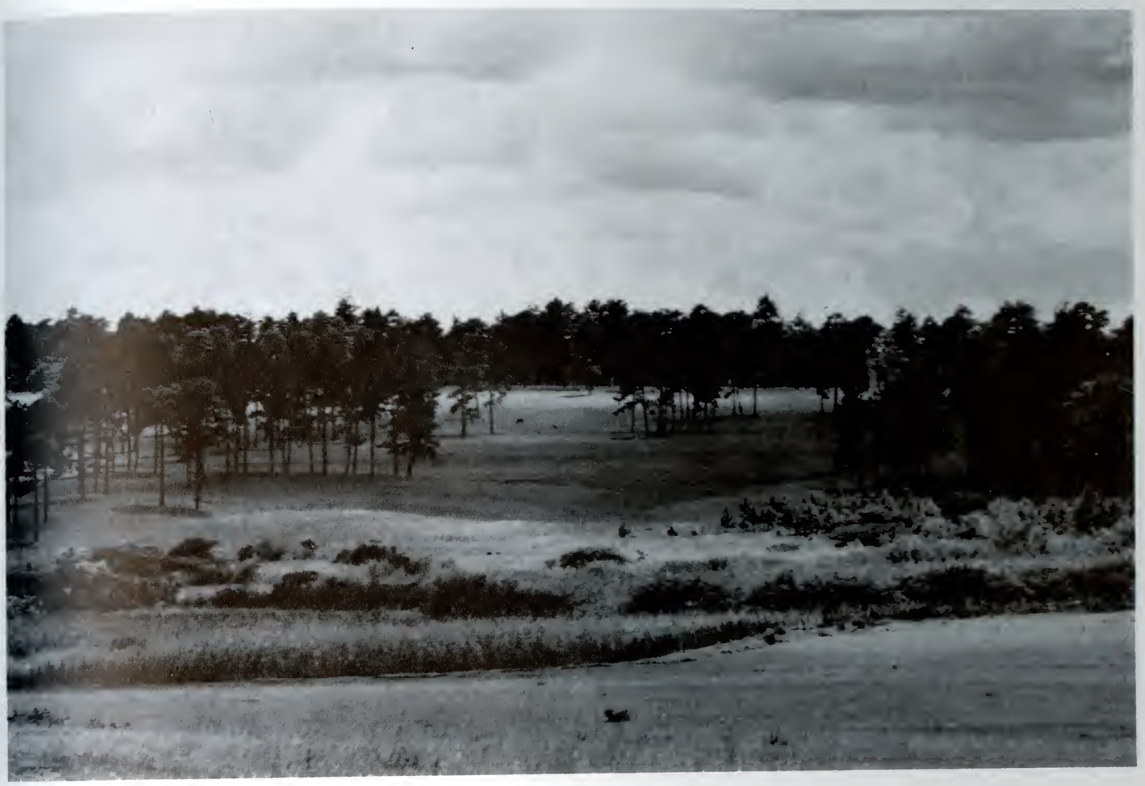

FIGURE 14. Pine Forest (a facies of Pine-Oak Forest) near Las Margaritas.

(10) *Pine-Oak Forest* (Pine-Oak Forest: Leopold, 1950; Pinares and Encinares: Miranda, 1952; Miranda and Hernández X., 1963; Bosque de Pino y Encino: Rzedowski and McVaugh, 1966) (Fig. 14).—On the dryer south and west slopes of the Central Highlands and on the eastern escarpment of the Sierra Madre, an open forest association occurs comprised of relatively few species of trees. Mixed pines and oaks are most common; however, stands of pure pine and pure oak occur in specialized edaphic situations. Trees range in height from 15 to 40 m and can be quite variable in their spacing. Epiphytes are sparse to common, but only heavy in canyon situations. The understory is usually herbaceous with occasional shrubs and often only low grassy patches between the trees. This formation is predominant between 1300 and 2500 m, with occasional associations occurring as low as 1000 m. The common trees are: *Arbutus xalapensis* H.B.K., *Buddleia skutchii* Morton, *Crataegus pubescens* (H.B.K.) Steud., *Pinus michoacana* Martinez, *Pinus oaxacana* Mirov, *Pinus oocarpa* Schiede, *Pinus pseudostrobus* Lindl., *Quercus acatenangensis* Trel., *Quercus corrugata* Hook., *Quercus crassifolia* H. & B., *Quercus mexicana* H. & B., and *Quercus rugosa* Nee. The following shrubs are common in this formation: *Buddleia crotonoides* A. Gray, *Ceanothus coeruleus* Lag., *Chiococca phaenostemon* Schlecht., *Garrya laurifolia* Hartw., *Holodiscus argenteus* (L.f.) Maxim., *Lippia chiapensis* Moldenke, *Litsea neesiana* (Schauer) Hemsl., *Mahonia vulcania* Standl. & Steyerm., *Monnina xalapensis* H.B.K., *Myrica cerifera* L., *Rhus schiedeana* Schlecht., *Senecio cristobalensis* Greenm., *Solanum hispidum* Pers., *Solanum nudum* H.B.K., *Viburnum jucundum* Morton.

WET-LAND FOREST FORMATIONS

(11) *Swamp and Lowland Riparian Forest* (Manglar, in part: Miranda and Hernández X., 1963; Canacoital: Pennington and Sarukhán K., 1968).—This very distinctive forest type occurs along all of the lowland rivers, especially where the water is slow moving, in flat, periodically inundated

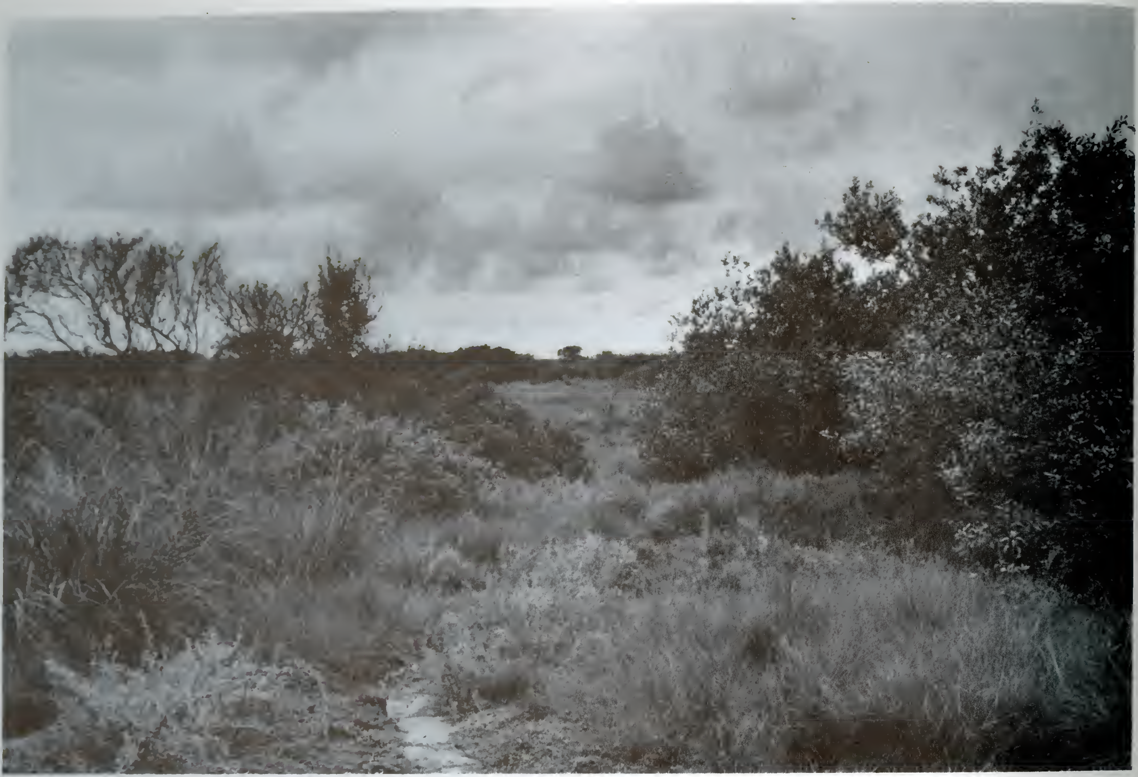

FIGURE 15. Mangrove Swamp and Herbaceous Marsh at Puerto Arista.

areas where water stands for some months of the year, and in freshwater swamps directly behind the mangrove swamp. The trees can often attain a height of 40 m with a continuous canopy and blend into the surrounding forest, but can also be as low as 15–20 m and occur in discontinuous patches of prominent green in a sea of dryer vegetation. The trees are characteristically buttressed and often have stilt roots and aerial roots resembling mangrove swamp. Stands of single or few species are common in this formation. The understory is sparse and usually herbaceous. Some of the common trees found here are: *Andira galeottiana* Standl., *Bravaisia integerrima* (Spreng.) Standl., *Bucida buceras* L., *Calophyllum brasiliense* var. *rekoi* Standl., *Haematoxylum campechianum* L., *Pachira aquatica* Aubl., *Salix chilensis* Mol., *Taxodium mucronatum* Tenore.

(12) *Mangrove Swamp* (Mangrove Swamp: Standley and Steyermark, 1945; Steyermark, 1950; Manglar: Miranda, 1952, 1957; Miranda and Hernández X., 1963; Rzedowski and McVaugh, 1966; Pennington and Sarukhán K., 1968) (Fig. 15).—Forming almost a continuous belt of low forest cover, this formation inhabits the entire Pacific coast of Chiapas in brackish, swampy conditions. This swamp is several kilometers wide in the north, in the region of the Mar Muerto, but only a few hundred meters wide along the rest of the coast. The vegetation is uniform and dense with the shrubs and trees with stilt roots and simple, thickly cutinized leaves. The stands are usually 4–7 m high but occasionally attain a height of 10–20 m. This association is widespread along the coast of tropical America as far north as Sonora and Baja California. The dominants are: *Avicennia germinans* (L.) L., *Conocarpus erecta* L., *Laguncularia racemosa* (L.) Gaertn., *Rhizophora samoensis* (Hochr.) Salv.; *Batis maritima* L., and *Philoxerus vermicularis* (L.) R. Br. are common herb associates.

(13) *Palm Forest* (Palmar: Miranda, 1952, 1957; Miranda and Hernández X., 1963; Rzedowski and McVaugh, 1966).—This forest, in which palms are the predominant trees, occurs along alluvial flats and terraces of the upper portion of the Central Depression, along the Río Usumacinta and its tributaries in the Eastern Highlands, and in scattered localities in the southern portion of the Pacific

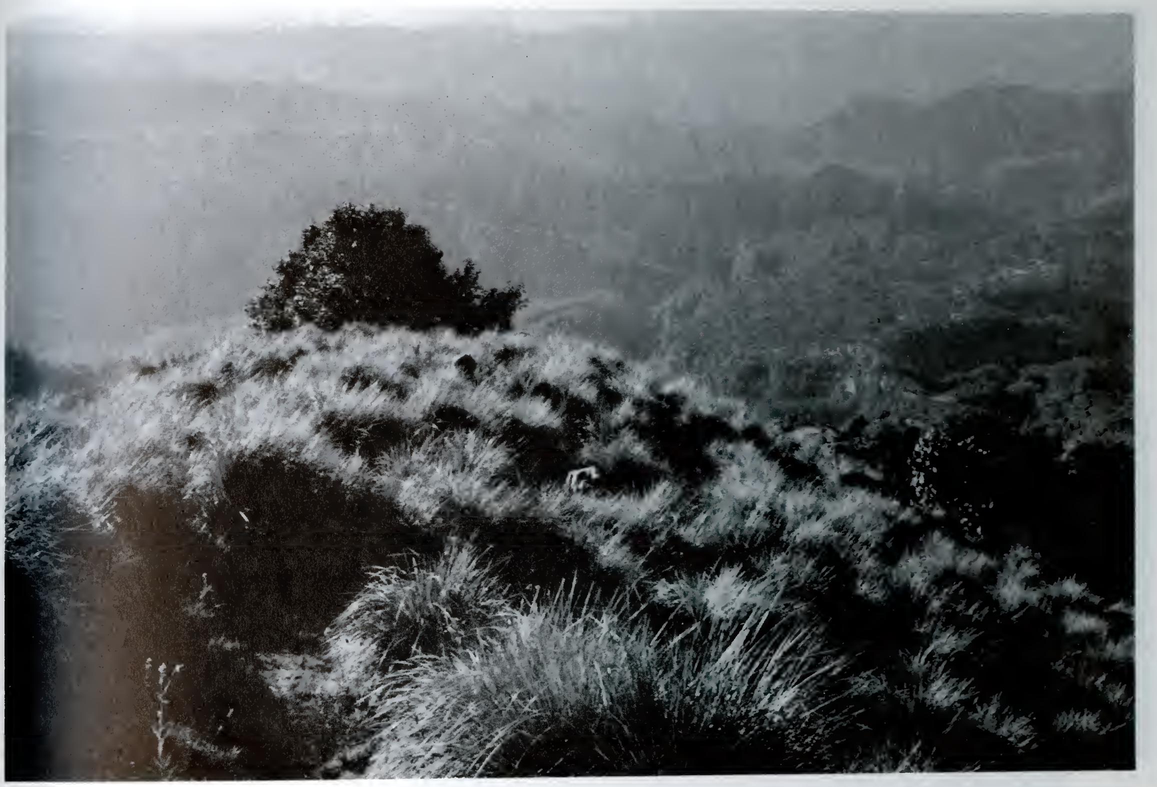

FIGURE 16. Bunch Grassland, southeast slope of Volcán Tacaná.

Coastal Plain. The forest is often found in poorly drained soils, and a sparse understory is characteristic except in the Eastern Highlands where a much denser understory is common. The palms reach between 24 and 40 m in height and can be quite closely spaced. Some of the common savanna trees are often associated with the palms. The dominant trees are *Sabal mexicana* Mart., *Scheelea liebmannii* Becc., and *Scheelea preussii* Burret.

(14) *Temperate Riparian Forest.*—This forest borders streams above 1500 m in the Central Highlands and the Sierra Madre. Numerous trees and shrubs common here are uncommon in the surrounding forest. The trees, often in very pure stands, are mostly between 10 and 25 m tall, beneath which a dense and often thicketlike understory is developed. The most common species are: *Acer negundo* var. *mexicanum* (DC.) Standl. & Steyerm., *Alnus acuminata* H.B.K. ssp. *acuminata, Baccharis heterophylla* H.B.K., *Berchemia scandens* (Hill) Trel., *Cornus excelsa* H.B.K., *Crataegus pubescens* (H.B.K.) Steudl., *Cuphea hyssopifolia* H.B.K., *Platanus chiapensis* Standl., *Salix bonplandiana* H.B.K., *Salix taxifolia* H.B.K.

TREELESS FORMATIONS

(15) *Bunch Grassland* (Zacatonal: Miranda, 1952, 1957; Miranda and Hernández X., 1963) (Fig. 16).—At high elevations in the Central Highlands and in the southern Sierra Madre, there occur extensive stands (often up to several hectares) of tall bunch grasses. The clumps are closely spaced and can be as tall as 2 m. The origins of this association may be secondary, but it appears to be quite stable. Common species are: *Briza rotundata* (H.B.K.) Hitchc., *Bromus carinatus* H. & A., *Festuca amplissima* Rupr., *Muhlenbergia gigantea* (Fourn.) Hitchc., *Muhlenbergia macroura* H.B.K., *Muhlenbergia robusta* (Fourn.) Hitchc., *Stipa ichu* (R. & P.) Kunth., *Stipa virescens* H.B.K., *Trisetum irazuense* (Kuntze) Hitchc.

(16) *Evergreen Cloud Scrub* (Paramo: Breedlove, 1973; Paramos de Altura: Miranda, 1952, 1957;

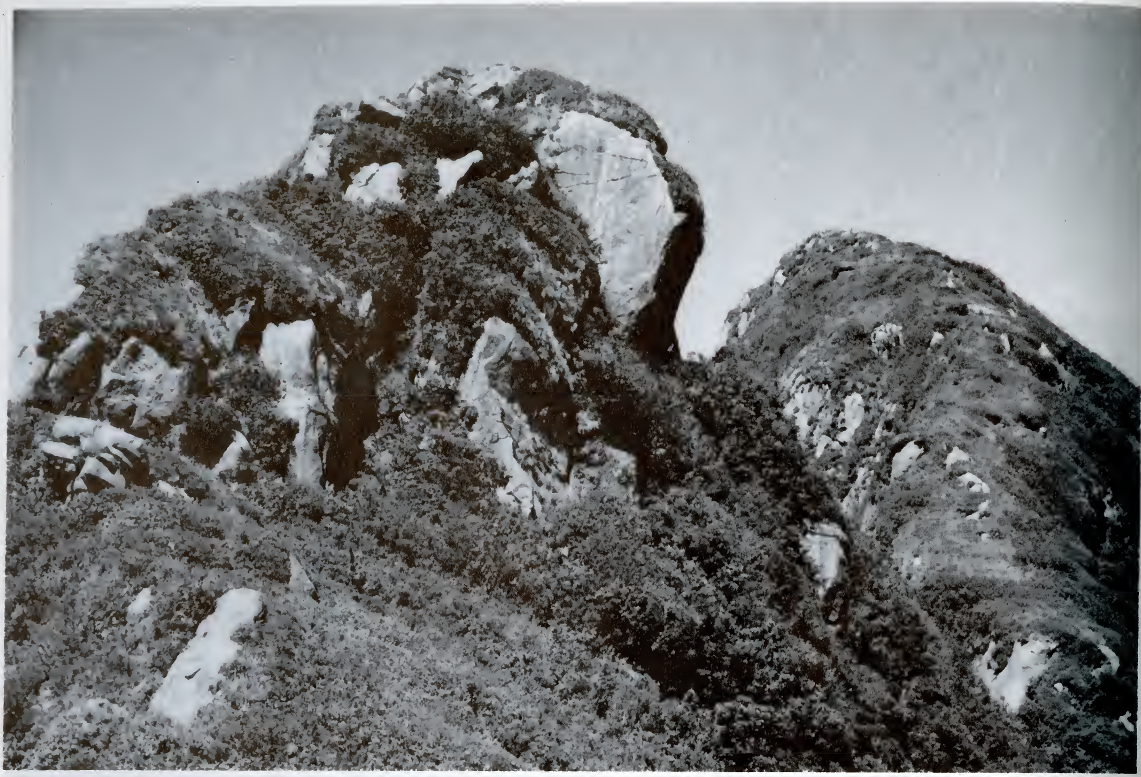

FIGURE 17. Evergreen Cloud Scrub, Cerro Tres Picos.

Miranda and Hernández X., 1963; Rzedowski, 1978; Tropical or Subtropical montane or subalpine, moist, wet or rain, Paramo: Holdridge, 1967) (Figs. 17 & 18).—On windswept peaks and high ridges in the Sierra Madre and the Central Highlands, a shrub formation occurs which is composed of plants with thick, small, evergreen leaves. The growth is so dense that one must walk on top of the formation to traverse areas covered by it. Many members of the heath family, lichens, mosses, and ferns are conspicuously abundant. This formation (see Figs. 17 & 18) is physiognomically similar to the Paramo of the Andes and Costa Rica, which is not considered to occur north of lat. 11°N (Cuatrecasas, 1968; Hastenrath, 1968; Weber, 1959); however, it is also similar to some Chaparral associations of California (Ornduff, 1974; Barbour and Major, 1977; Munz and Keck, 1949, 1950). The use of the present term, Evergreen Cloud Scrub, avoids any confusion with either of these widespread and variable plant formations. The common species that occur in this formation are: *Alchemilla pinnata* R. & P., *Arenaria bryoides* Willd., *Beschorneria chiapensis* Matuda, *Calamagrostis tolucensis* (H.B.K.) Trin., *Comarostaphylis pyrifolia* Donn.-Smith, *Draba volcanica* Benth., *Festuca tolucensis* H.B.K., *Gaultheria cumingii* Sleumer, *Gaultheria odorata* Willd., *Gleichenia* spp., *Gnaphalium vulcanicum* I. M. Johnst., *Haplopappus stoloniferus* DC., *Holodiscus argenteus* (L.f.) Maxim., *Lupinus montanus* H.B.K., *Luzula racemosa* Desv., *Lycopodium* spp., *Muhlenbeckia volcanica* (Benth.) Endl., *Myrrhidendron donnellsmithii* C. & R., *Pernettya ciliata* (S. & C.) Small, *Pernettya hirsuta* (Mart. & Gal.) Camp, *Pernettya tomasii* Camp, *Potentilla heterosepala* Fritsch, *Ternstroemia tepezapote* S. & C., *Trisetum irazuense* (Kuntze) Hitchc., *Vaccinium confertum* H.B.K., *Vaccinium haematinum* Standl. & Steyerm., *Vaccinium matudae* Lundell, *Vaccinium minarum* Standl. & Steyerm., *Weldenia candida* Schult., *Werneria nubigena* H.B.K.

(17) *Herbaceous Marsh* (Tulare: Miranda and Hernández X., 1963; Popal: Miranda and Hernández X., 1963).—This distinct herbaceous cover over shallow standing water has very different associations in temperate and lowland situations. In the larger nondraining valleys of the Central

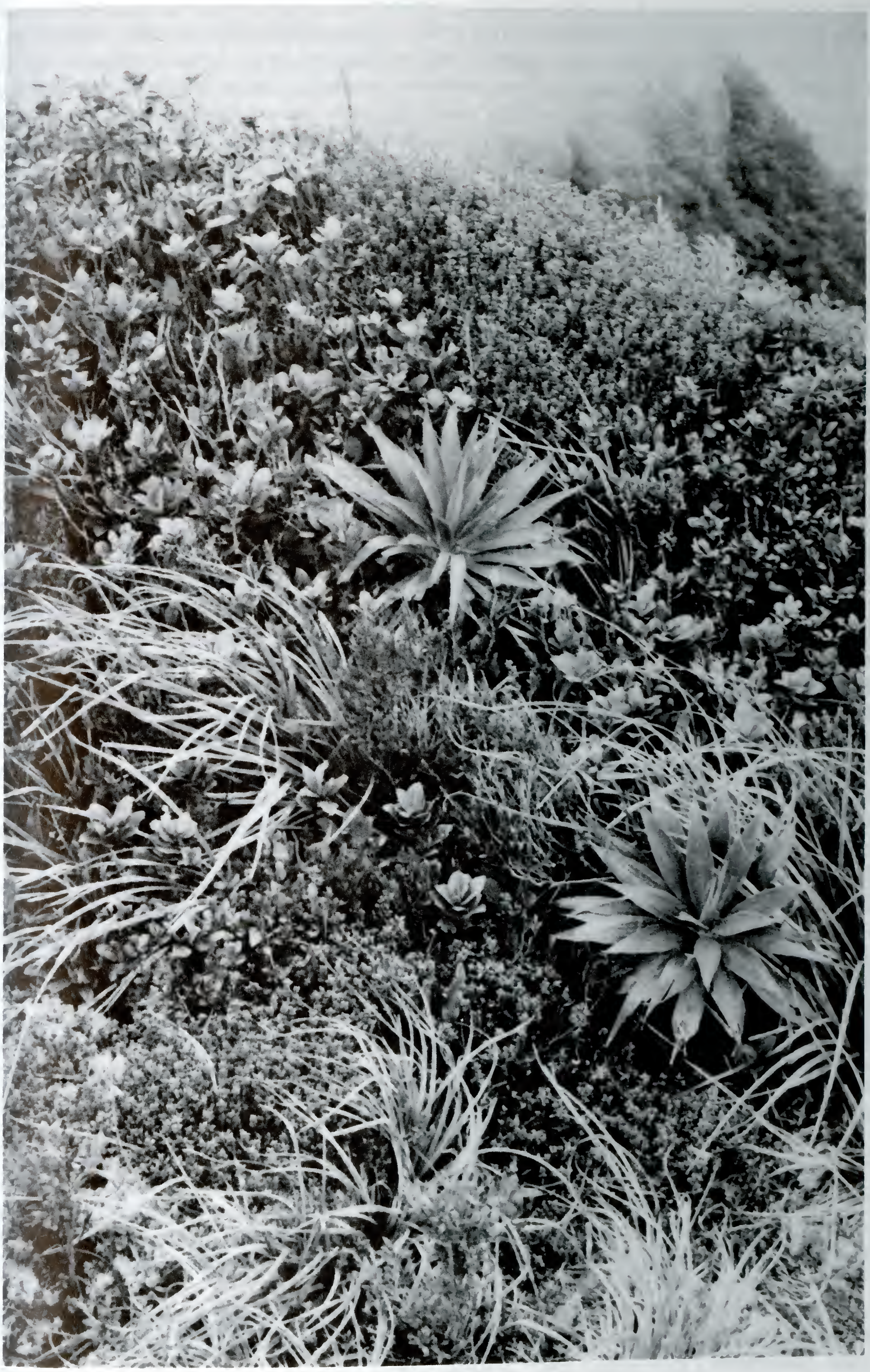

FIGURE 18. Detail of Evergreen Cloud Scrub, Cerro Tres Picos.

Highlands and in local areas of the Sierra Madre, a temperate marsh occurs which is often associated with bogs. *Carex* spp., *Cladium jamaicense* Crantz, *Cyperus* spp., *Juncus* spp., *Ludwigia peruviana* (L.) Hara, *Lythrum vulneraria* Schrank, *Rhynchospora* spp., *Scirpus californicus* (C. A. Meyer) Steudl., and *Typha latifolia* L. are common associates. Large tracts of the Gulf Coastal Plain and some smaller areas on the Pacific Coastal Plain are covered with a tropical marsh which in some areas becomes quite dry seasonally. In addition to many of the species present in the temperate marshes, these lowland associations have the following common species: *Calathea* spp., *Caperonia palustris* (L.) St. Hil., *Heliconia bihai* L., *Hymenachne amplexicaulis* (Rudge) Nees, *Leersia* spp., *Neptunia plena* (L.) Benth., *Nymphaea blanda* G. F. W. Mey., *Paspalum* spp., *Phragmites australis* (Cav.) Trin. ex Steudl., *Sesbania emerus* (Aubl.) Urb., and *Thalia geniculata* L.

(18) *Coastal Strand* (Cordon Littoral: Miranda, 1942).—On sandy portions of the immediate Pacific Coast, the dunes are stabilized by an herbaceous association with scattered sprawling shrubs. The dominants are: *Acanthocereus horridus* Britt. & Rose, *Alibertia edulis* (L. Rich.) A. Rich., *Canavalia maritima* (Aubl.) Thouars, *Capparis cynophallophora* L., *Coccoloba venosa* L., *Distichlis spicata* (L.) Greene, *Ipomoea pes-caprae* L., *Monanthocloë littoralis* Engelm., *Okenia hypogaea* S. & C., *Pectis multiflosculosa* (DC.) Sch. Bip., *Prosopis juliflora* (Sw.) DC., *Salpianthus arenarius* H. & B., *Sesuvium portulacastrum* L., *Stegnosperma halimifolium* Benth., *Uniola pittieri* Hack., *Ximenia parviflora* Benth.

(19) *Second-growth and Successional Forest, and Shrub Associations.*—Either for lumber, pasture, or some crop, great expanses of virgin forest are presently being cut down in Chiapas. In many areas successional forests are being cut for the planting of maize or for firewood and charcoal. These decimated lands recover slowly, and it would take several centuries to replace the primary forest. Second-growth associations are prominent and are, in some areas, the dominant vegetation. This account does not attempt to describe the myriad of possible successions and their component associations. One example to illustrate this vegetation type is given here.

When the Pine-Oak, Pine-Oak-*Liquidambar,* and Evergreen Cloud Forest associations are cut off, burned, planted to maize, and after a few years allowed to grow back, the regeneration begins with a scrub association which can last for as long as 10 years. This man-perpetuated succession has been going on in this area for several thousand years. Many of the races of maize used are narrowly restricted endemics (Wellhausen et al., 1952, 1957). This association is naturally quite variable in its composition depending upon the locality and the forest type which it is succeeding. It is usually a quite uniform cover of shrubs and herbaceous plants up to three meters tall. Common species are: *Abutilon tridens* Standl. & Steyerm., *Acacia augustissima* (Mill.) Kuntze, *Arctostaphylos lucida* (Small) Standl., *Baccharis vaccinioides* H.B.K., *Calliandra grandiflora* (L'Her.) Benth., *Calliandra houstoniana* (Mill.) Kuntze, *Ceanothus coeruleus* Lag., *Clibadium arboreum* Donn.-Smith, *Coaxana ebracteata* Rose, *Lantana hirta* Grah., *Lantana hispida* H.B.K., *Lippia hypoleia* Briq., *Malvaviscus arboreus* Cav., *Muhlenbeckia tamnifolia* (H.B.K.) Miessn., *Pavonia paniculata* Cav., *Smallanthus maculatus* (Cav.) H. Robins., *Rhamnus discolor* (Donn.-Smith) Rose, *Rhamnus nelsonii* Rose, *Rubus* spp., *Salvia* spp., *Tithonia diversifolia* (Hemsl.) A. Gray, *Tithonia longiradiata* (Bertol.) S. F. Blake, *Vernonia leiocarpa* DC., *Viburnum lautum* Morton.

History and Extent of Exploration

In 1796 the first botanical explorer reached Chiapas. Since that time there has been a discontinuous but regular flow of explorers and collectors to the state, each with his own specialties or regions sampled. Despite this seemingly long history, the number of specimens collected before the 1940's was very small, perhaps under 7000. The following is an encapsulated résumé of the major collectors from 1796 until 1964.

José Mariano Mociño (1757–1820)—A member of the Royal Botanical Expedition to New Spain, Mociño visited Chiapas in June 1796 (Ciudad Real, Comitán) on his way to Guatemala, El Salvador, and Nicaragua (McVaugh, 1969; Beltrán, 1968; Rickett, 1947; Maguire, 1958; Standley, 1920). He returned the same way in August 1798 and spent several months treating an outbreak of leprosy in Chiapa de Corzo. Those of his collections that have persisted from this trip are at Madrid and were never used in the preparation of any botanical work. Some of them are referred to in the *Flora Mexicana* (1888) as Reino de Guatemala. His manuscript, *Flora de Guatemala,* which treats his Chiapas material, was never published. He was accompanied on his journey by the artist Juan de Dios Vicente de La Cerda. Material at MA with some fragments at F.

Carl Theodor Hartweg (1812–1871)—Hartweg was sent by the Horticultural Society of London to collect material in Mexico and Central America. He passed through Chiapas on his way to Guatemala in 1839 and made some collections near Comitán (McVaugh, 1970; Hemsley, 1888). Material from his expedition was described by G. Bentham in *Plantae Hartwegianae* (1839–1857). Material at BM & K.

Jean Jules Linden (1817–1898)—Linden came to Mexico to collect plants with the support of the Belgian government. After collecting in Veracruz and Oaxaca, he worked his way through Tabasco and Chiapas into Guatemala (Lasegue, 1845; Clokie, 1964; Coats, 1969). His material was used in the work of Hemsley (*Biologia Centrali-Americana*) and others. Some of the localities that appear on his collections from his explorations in Chiapas (1839–1841) are: Bochil, Amatenango, Chamula, Comitán, Cacaté, Ciudad Real, Jitotol, Pueblo Nuevo Solistahuacán, San Bartolomé, Solusuchiapa. Material at F, G, K, LE.

Auguste Boniface Ghiesbreght (1810–1893)—Ghiesbreght visited Chiapas for the first time on the same Belgian expedition with Funk and Linden. After collecting in South America, he settled in San Cristóbal de las Casas in 1862 and remained until his death (Rovirosa, 1889; Margalli, 1893; Miranda, 1953). Material from his later visit was labeled Chiapas etc. 1864–1870. His specimens were studied by a variety of botanists including A. Gray (*Ghiesbreghtia*). Some of the localities appearing on his collections are: Las Nubes (near San Bartolomé), San Cristóbal, Teopisca, Cerro Huitepec. Material at BM, BR, CAS, GH, K, LE, and others.

José Narciso Rovirosa (1849–1901)—This naturalist was born in Tabasco and lived many years in Chiapas in the region of Ixtacomitán. He became professor of the Instituto Juárez in Villahermosa, Tabasco, in 1887. He is the author of many articles on the biology and exploration of southern Mexico and an excellent study (1909) of the ferns of Tabasco and Chiapas. His explorations and collections were made mostly in the eastern portion of the Central Highlands, and also in the Northern and Eastern highlands. Some of the localities on his specimens are: Ixtacomitán, Rayón, Pantepec, Coapilla, Tapalapa, Chapultenango, Solusuchiapa, Zacualpan, Tumbala, Yajalón, Ocotepec, Ixtapa, Soyaló, Bochil, Pichucalco. Material at K, MEXU, NY, PH, US. His personal herbarium which was housed in Villahermosa, Tabasco, seems to have been lost.

Georg Eduard Seler and Caecilie Seler (1849–1922)—This couple visited Chiapas in 1896 to conduct an anthropological survey (Seler, 1897). They collected almost 1000 plants, all of which were deposited at Berlin and subsequently destroyed during the second World War. All that remains are a few exsiccatae scattered throughout the world. Their plants were studied by Loesener, Engler, and others, with many new taxa described. Some of the localities visited were Ocozocoautla, Tuxtla Gutiérrez, Ixtapa, Huistán, Oxchuc, Tumbala, Palenque and Comitán. Material at B, CAS, DS, GH.

Edward William Nelson (1855–1934)—Nelson collected widely in Mexico and Guatemala while making a survey for the United States Department of Agriculture (USDA) from 1892–1906. He traveled and collected throughout most of the physiographic regions of Chiapas in 1895–1896, and in 1899. His collections were studied by a variety of botanists including J. N. Rose, B. L. Robinson, G. M. Greenman, and P. C. Standley. For a detailed itinerary and list of collecting localities see Goldman (1951). Material at F, GH, US.

Edward Alphonso Goldman (1873–1946)—Goldman accompanied Nelson on the USDA survey and worked primarily with vertebrates. However, he returned to Chiapas in 1904 and made many plant collections in the Central Depression and Central Highlands. His collections were studied with those of Nelson. Material at US.

Carl Albert Purpus (1851–1941)—This German collector lived and traveled extensively throughout Mexico from 1897 until his death. He made repeated visits to Chiapas (1913, 1914, 1923, 1925, 1926, 1930), and his collections were sent to his friend T. S. Brandegee at the University of California, who studied and published on them. After the death of Brandegee in 1925, Purpus sent his

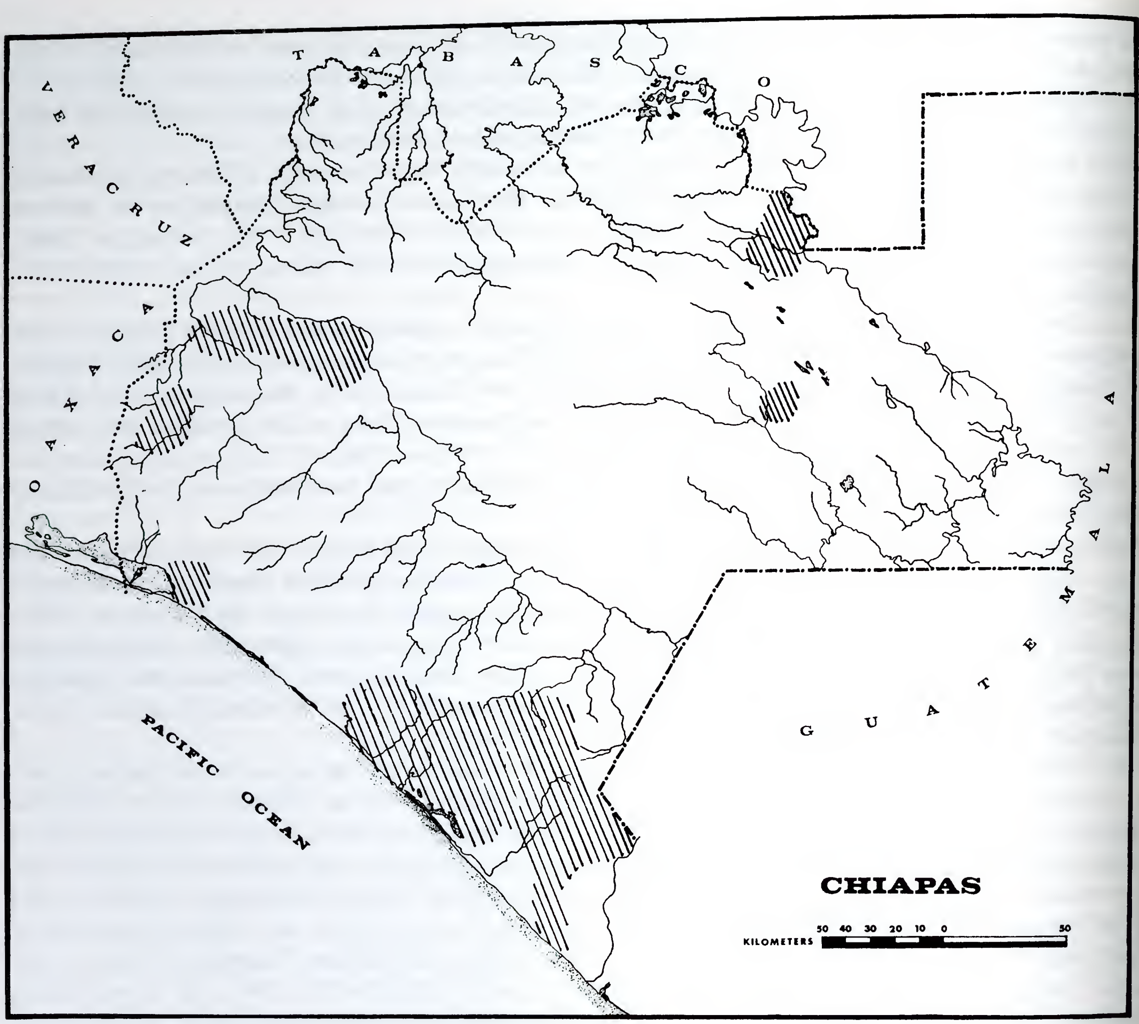

FIGURE 19. Major areas visited by Purpus, Miranda, and Matuda, the three major collectors prior to 1964.

material to P. C. Standley. Sousa Sanchez (1969) gives an excellent treatment of the Mexican period of the life of Purpus and an enumeration of his collecting localities. Material at DS, UC, US.

Eizi Matuda (1894–1978)—Matuda came to Chiapas in 1922 to join a Japanese agricultural colony. He began collecting plants in the Soconusco region in 1935 and collected heavily in the Sierra Madre and to some extent in other parts of the state continuously until 1949. Thereafter, he visited the state sporadically on collecting trips until his death. Matuda sent his material to C. L. Lundell, then at the University of Michigan, who wrote many articles on them. Matuda has published two enumerations of his collections (1950a, 1950b) with localities and many taxonomic articles on various groups, especially Araceae and Bromeliaceae. Material at DS, F, K, LL, MICH, MEXU, NY.

Faustino Antonio Miranda Gonzalez (1905–1964)—Born in Spain, this astute biologist first visited Chiapas in 1941 (Miranda, 1942). He returned to spend the years 1949–1954 in Tuxtla Gutiérrez under the auspices of the state government, and during this period he organized the Botanical Garden there. Near the end of his stay in Chiapas, he published *La vegetación de Chiapas* (1952, 1953), which remains the only work treating the flora of the state. He also wrote many smaller articles about the plants of Chiapas and described many new taxa (Rzedowski, 1966). His collections and work in the warm zones of the state are invaluable. Material at DS, F, MEXU, US.

There were three (Purpus, Miranda, and Matuda) whose scope and time spent in the state enabled them to make by far the most collections. Together they collected over 20,000 specimens. Figure 19 shows the areas of the state explored by these men.

In 1948 Mexico began a program of road building, and by 1954 paved roads crossed Chiapas for the first time. Understandably, a great number of professional and amateur botanists now had easy access to the state. No attempt will be made to list all of those who collected plants in the state since this time. A. R. Smith (1981) in his contribution to the *Flora of Chiapas* lists 43 who collected ferns.

A number of projects have been undertaken which produced materials that are very useful in the *Flora of Chiapas*. Chief among these is the work done in connection with the Comisión de Estudios sobre la Ecología de Dioscóreas (Gómez P., Vasquez S. and Sarukhán K., 1964; Pérez J. and Sarukhán K., 1970); also the Subsecretaria Forestal y de La Fauna produced a forest inventory for Chiapas (Anon., 1976). There were three other smaller investigations which yielded materials relevant to the flora and which had published reports (Carlson, 1954; Dressler, 1957; Zuill and Lathrop, 1975).

D. E. Breedlove began his interest with the Chiapas flora in 1964 while doing work in connection with an ethnobotanical project funded by two successive grants from the National Science Foundation (NSF) (GS-383, GS-1183). These projects produced the book *Principles of Tzeltal Plant Classification* (Berlin, Breedlove, and Raven, 1974) and several smaller articles. These projects enabled Breedlove to spend 22 months in the field and amass 17,000 collections, 7000 of these with the help of collaborators A. S. Ton (nos. 1–4000) and R. M. Laughlin (nos. 1–3000), along with Breedlove nos. 5900–15,500. By 1970 the majority of this material was labeled and determined.

A second project (NSF GB-29483x) was funded to further explore the state botanically and to organize the mass of collections for the production of a published flora of the state of Chiapas. During this period Breedlove collected 15,000 additional specimens (Breedlove nos. 19,778–35,448) over a twenty-month stay in remote areas of the state. Up to this point the following collaborators worked with Breedlove: P. H. Raven, 8076–8455, 12886–13748, and Raven nos. 19763–20142; R. F. Thorne, 20413–21537, 30016–31201; A. R. Smith, 21538–22848, 31265–32760; E. McClintock, 23445–23838, 34014–34305; R. L. Dressler, 29927–30015. Subsequently, the California Academy of Sciences supported a four-month trip to the dry regions of the state in 1974 resulting in 2650 collections (Breedlove nos. 36,421–39,150), and in 1976 the Stanley Smith Horticultural Fund supported six months of botanical exploration concentrating on plants suitable for cultivation. In this period another 3400 collections (Breedlove nos. 39,519–42,891) were made.

In addition, numerous workers involved in floristic, chemical, and anthropological projects in the state have deposited their collections at the California Academy of Sciences in return for determination of the specimens. This material totals another 3500 specimens; the major contributors are R. F. Thorne, E. L. Lathrop, H. Zuill, O. Clarke, D. Dreyer, and B. Voorhies.

All of this material totals 42,000 specimens of which the primary set is deposited at the Herbarium of the California Academy of Sciences. It has all been mounted, labeled, determined, and organized by family and has been actively loaned to systematic workers throughout the world. Figure 20 shows the distribution of Breedlove primary collections in the state with each dot representing 50 collections. More than 100,000 duplicates have been distributed to the following herbaria: CHAPA, ENCB, DUKE, F, GH, INIF, LL, MEXU, MICH, MO, NY, RSA, TEX, US.

The Scope and Plan of the Flora

Realistically, in this day and age no one person could ever complete a flora of this size without help from contributors, and their cooperation is actively sought. Specialists in particular families whose research would allow the production of appropriate treatments are urged to contact D. E. Breedlove and arrange the production of their contribution.

Ideally, a flora is organized to allow easy retrieval of information, and it should be a source for others to use in their own work. As such, the sequence of plant families one chooses directly relates to the ease with which information can be obtained. A strict alphabetical system would therefore be the best system for all types of uses (botanists and nonbotanists alike), and in this work genera

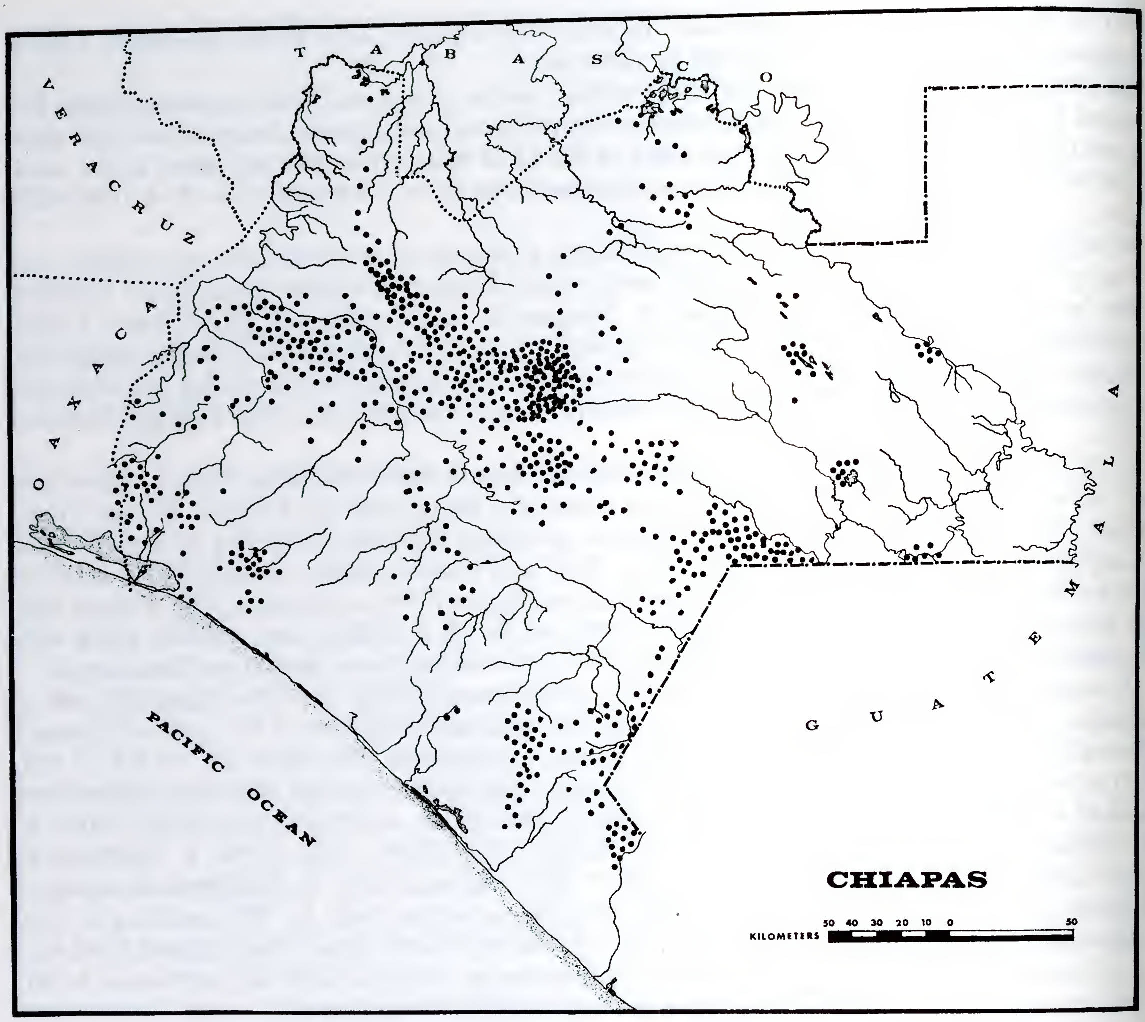

FIGURE 20. Location of collections generated by the Flora of Chiapas Project. One dot represents 50 collections.

and species will be listed alphabetically. Any large family (more than 250 species) will be published as a separate volume. The great body of information now available about the higher classification of plant taxa makes it impossible to ignore the interrelationships of the plant families, and for this reason, the remaining families will be grouped into volumes containing about 500 species and organized in the sequence of families delineated by Thorne (1968, 1976). However, the volumes themselves may not be published in order, and this will depend on collaborators and the state of knowledge about the particular families involved. The treatment for each family will contain:

1. An introduction delimiting special problems, techniques, literature, and other subjects pertinent to that group.
2. A short description of the family.
3. Keys to all genera and species known from the state.
4. For each species and genus, listing of important synonymy, with typification of all basionyms.
5. References to good illustrations and relevant literature (monographs, revisions).
6. Descriptions of all genera and species (with emphasis on diagnostic characters).
7. Chromosome numbers.
8. Habitat and vegetational formations for all species.
9. Local common names and uses when applicable.

10. Statement on abundance for all species.
11. Distribution of genera and species, both within and outside Chiapas; distributions within Mexico indicated for each state.
12. Elevational distribution in Chiapas.
13. Specimen citations (collector and number, herbarium).
14. Discussion of problems of taxonomy (circumscription and nomenclature).
15. Discussions of species known from adjacent areas possibly to be expected in Chiapas.

This general format will be used throughout the work, but minor variation will be allowed to accommodate the diverse groups of plants treated and the different states of knowledge about them.

Although desirable, it will be impossible to illustrate every species for this flora; however, illustrations greatly enhance the value of such a work and at least one per genus will be included. In general, species that will be illustrated will be ones that have either poor or no illustrations published for them in the past.

No new taxa will be published in this flora; workers are encouraged to publish new names and combinations separately.

The abbreviations that will be used in the text are listed in the Appendix. Citations for periodic literature will follow the abbreviations in *Botanico-Periodicum-Huntianum* (BPH) (Lawrence et al., 1968).

After completion of the flora, a comprehensive index and gazetteer will be published and a volume of additions and corrections will undoubtedly be necessary.

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At the time of writing this introduction, sixteen years have gone into the collection and organization of materials for inclusion in the *Flora of Chiapas*. Many, many people from maize farmers to heads of government agencies have directly helped in a myriad of ways so that without their help the completion of this work would have been impossible. I take this opportunity to thank all those who have helped in manners great and small.

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Various individuals, institutions, and authorities in the state of Chiapas have helped throughout the course of this work, and their support is here gratefully acknowledged. Especially, I would like to thank the government of the state of Chiapas through its many agencies that have helped in this work, and Dr. Manuel Velasco Suárez, Gobernador Constitucional del Estado, whose cognizance of the importance of works like this one has provided the moral support needed to complete the project. Miguel Alvarez del Toro of the Instituto de Historia Natural del Estado provided much information about the location of intact stands of forests. Prof. José Weber was particularly helpful

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APPENDIX–ABBREVIATIONS*

aff., related to
Afr., Africa
Aguasc., Aguascalientes
Ala., Alabama
Alas., Alaska
Am., America
Antill., Antilles
Arg., Argentina
Ariz., Arizona
Ark., Arkansas
Atl., Atlantic
Austral., Australia
Bah. Is., Bahama Islands
Baja C.N., Baja California Norte
Baja C.S., Baja California Sur
B.C., British Columbia
Bel., Belize [or Belice; formerly Br. Honduras]
Berm., Bermuda
Bol., Bolivia
Braz., Brazil
Br. Gui., British Guiana
C.A., Central America
ca., circa
Calif., California
Camp., Campeche
Can., Canada
Carib., Caribbean
cen., central
cf., confer (compare)
Chih., Chihuahua
Chis., Chiapas
cm, centimeter
Cma., Colima
Co., county
Coah., Coahuila
Col., Colombia
Colo., Colorado
comb., combination
C.R., Costa Rica
cult., cultivated
Dept., Departamento
D.F., Distrito Federal
Dgo., Durango
diam., diameter
Dist., Distrito
E, east, eastern
Ecu., Ecuador
Edo., Estado
elev., elevation
Eur., Europe
Euras., Eurasia
exsicc., exsiccata
f., filius, forma
Fla., Florida
fragm., fragment
Fr. Gui., French Guiana
Ga., Georgia
Gal., Galápagos
Gr. Antill., Greater Antilles
Gro., Guerrero
Gto., Guanajuato
Guat., Guatemala
Gui., Guianas
Guy., Guyana [formerly Br. Guiana]
Haw., Hawaii
Hgo., Hidalgo
Hisp., Hispaniola
Hond., Honduras
hwy., highway
I., Is., island (—s)
Ill., Illinois
illegit., illegitimate
Jal., Jalisco
Jam., Jamaica
Jap., Japan
J. Fernán., Juan Fernández
La., Louisiana
L. Antill., Lesser Antilles
m, meter
Madag., Madagascar
Males., Malesia
Md., Maryland
Me., Maine
Méx., México (state of)
Mex., Mexico (country)
mi., miles
Mich., Michoacán
Mlos., Morelos
mm, millimeter
Mo., Missouri
mt., mts., mountain (—s)
munic., municipio
N, north, northern
N.A., North America(n)
Nay., Nayarit
N.C., North Carolina
NE, northeast, northeastern
Nev., Nevada
Nic., Nicaragua
N. Gui., New Guinea
N.L., Nuevo León
N.M., New Mexico
no., nos., number (—s)
nom. nov., nomen novum (new name)
nom. nud., nomen nudum (naked name)
nom. superfl., superfluous name
NW, northwest, northwestern
N.Z., New Zealand

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* Not always the same as for literature references, which follow B-P-H (e.g., Venez. cf. Ven., Amer. cf. Am.).

Oax., Oaxaca
Okla., Oklahoma
O.W., Old World
Pac., Pacific
Pan., Panama
Parag., Paraguay
Polyn., Polynesia
P.R., Puerto Rico
pt., part
Pue., Puebla
Qro., Queretaro
Q. Roo, Quintana Roo
Que., Quebec
R., river or río
rd., road
s, south, southern
S.A., South America
S. Afr., South Africa
Salv., El Salvador
S.C., South Carolina
S.D., South Dakota
SE, southeast, southeastern
sect., section
Sin., Sinaloa
s.l., sensu lato, in the broad sense
S.L.P., San Luis Potosí
Son., Sonora
sp., species (singular)
spp., species (plural)
s.s., sensu stricto, in the narrow sense
ssp., subspecies (singular)
sspp., subspecies (plural)
subg., subgenus
subtrop., subtropical
Sur., Surinam
sw, southwest, southwestern
syn., synonym
Tab., Tabasco
Tam., Tamaulipas
Tex., Texas
Tlax., Tlaxcala
Tob., Tobago
Trin., Trinidad
trop., tropical
U.S., United States
Urug., Uruguay
Va., Virginia
var., variety
Ven., Venezuela
Ver., Veracruz
vol., volcán
Vt., Vermont
w, west, western
Wash., Washington
W.I., West Indies
Wis., Wisconsin
Yuc., Yucatán
Zac., Zacatecas

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